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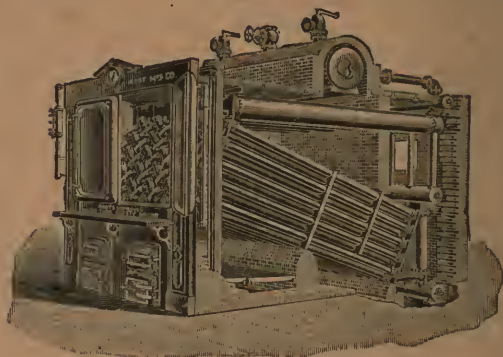
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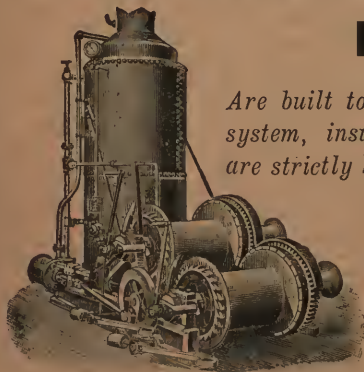


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77



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TABLE OF CONTENTS.

	PAGE.
HISTORICAL, <i>Prof. R. C. Carpenter</i>	v
HISTORICAL, <i>F. Hodgman</i>	xi
ADVANTAGES OF ENGINEERING SOCIETIES, <i>E. W. Muenscher</i>	xxiv
PRESIDENT'S ADDRESS, <i>Chas. E. Greene</i>	3
WATER WASTE IN THE WATER-WORKS PLANTS, AND ITS PRE- VENTION, <i>A. L. Holmes</i>	13
COAL AND COAL-MINING IN MICHIGAN, <i>Charles Holmes</i>	35
DERIVATION AND APPLICATION OF A USEFUL AND CONVENIENT AZIMUTH FORMULA, <i>John G. Mc Elroy</i>	59
INSPECTION OF U. S. SURVEYS OF PUBLIC LANDS, <i>A. W. Bar- ber</i>	76
WITH THE EARLY SURVEYORS OF INDIAN TERRITORY, <i>O. H. Todd</i>	83
A SUGGESTION ON IRRIGATION, <i>A. L. Reed</i>	96
SECOND-GROWTH TIMBER IN NORTHERN MICHIGAN, <i>J. J. Hubbell</i> ,	99
STREET PAVING IN MICHIGAN.....	106
THE CONSTRUCTION OF A STONE MASONRY HIGHWAY BRIDGE AT HYDE PARK, DUCHESS CO., NEW YORK, <i>Owen Morris</i> ,	113
RECENT LEGAL DECISIONS.....	155
U. S. INSPECTION OF LAND SURVEYS, <i>Geo. E. Steele</i>	173
MICHIGAN ENGINEERING SOCIETY, ANNUAL CONVENTION	177
THAT COMPASS: A REMINISCENCE, <i>Dorr Skeels</i>	186
A LETTER FROM WM. B. SEARS	191
REMINISCENCES, <i>Wm. Appleton</i>	199
A TOAST—CURVES AND TANGENTS, <i>J. J. Hubbell</i>	209
THE MICHIGAN ENGINEERING SOCIETY—ITS FELLOWSHIP, <i>F. Hodgman</i>	213

INDEX TO ADVERTISEMENTS.

Abendroth & Root Mfg. Co.....	2d page Cover
Lidgerwood Mfg. Co.....	2d page Cover
Milwaukee Cement Co.....	vi
Pacific Flush Tank Co.....	viii
Loomis & Nyman.....	x
Atlas Cement Co.....	xii
J. H. Somer's Coal Co.....	xiv
Owen Morris.....	xiv
R. D. Wood & Co.....	xvi
Michigan Agricultural College.....	xvi
Evens & Howard.....	xviii
National Meter Company.....	xviii
Weber Railway Joint Manufacturing Co.....	xx
Union Akron Cement Co.....	xx
Detroit Graphite Mfg. Co.....	xxii
Fauth & Co.....	xxii
C. L. Berger & Sons.....	xxii
The International Correspondence Schools.....	xxii
R. Seelig.....	xxiv
Schillinger Bros. Co.....	xxiv
The Toledo Bridge Co.....	xxiv
Saginaw Coal Co.....	xxiv
The Jeffrey Mfg. Co.....	xxvi
Michigan Engineering Society.....	xxvi
Thomson Meter Co.....	xxviii
Review and Herald Pub. Co.....	xxx
Manual of Land Surveying.....	xxxii
Surveyors' Tables.....	xxxii
Field Books for Surveyors.....	xxxii
Neptune Meter Company.....	190
Riggs & Sherman.....	192
Coal Lands.....	192
Fred C. Zimmermann.....	192
Russel Wheel & Foundry Co.....	192
The Q. & C. Co.....	Colored Insert
The Engineering and Mining Journal.....	194
Frank W. Hoyt.....	194
American Engineer, Car Builder, and Railroad Journal.....	194
The Railway Review.....	194
Muskegon Boiler Works.....	196
The Arbuckle Ryan Co.....	198
The Engineering News.....	200
The Engineering Record.....	202
Poetry and Music.....	202
James Leffel & Co.....	202
Battle Creek Steam Pump Co.....	204
Wickes Bros.....	206
Sandusky Portland Cement.....	206
The Massillon Bridge Co.....	208
Keuffel & Esser Co.....	208
Hersey Mfg. Co.....	210
Meacham & Wright.....	210
L. Beckmann.....	210
Lufkin Rule Co.....	212
Geo. M. Eddy & Co.....	212
Michigan Engineers' Annual.....	214
F. Hodgman.....	216
Western Electrical Instrument Co.....	3d page Cover
Wm. Jessops & Sons, Ltd.....	3d page Cover
Western Cement Co.....	3d page Cover
W. & L. E. Gurley.....	4th page Cover

SPECIAL PAPERS READ AT THE TWENTIETH CONVENTION — HISTORICAL.

PROF. R. C. CARPENTER.

To the President and members of the Michigan Engineering Society.

GENTLEMEN: In accordance with my promise made your secretary some months ago, I enclose a short description of the work done in organizing the Michigan Association of Surveyors and Civil Engineers, which I believe is the direct lineal ancestor of the Michigan Engineering Society.

The Michigan Association of Surveyors and Civil Engineers was organized March 25, 1880, as the result of a circular issued Feb. 28, 1880, and printed in full in the report of the first annual meeting. This circular was in great part written by J. E. Sherman, then chief clerk in the Land Office, and who was elected secretary of the association for two successive years.

The question of an organization of the surveyors and civil engineers had been discussed many times previous to the time of issuing this circular, and an organization had been perfected as early as Aug. 20, 1868, and two meetings held, one in Lansing and one in Grand Rapids. The principal object of the earlier association seems to have been that of securing legislation to abolish the county surveyor; and, as will be noted by looking at the earlier reports of this society, that question was an extremely lively one for the first two or three years. One of the special objects which led to the organization in 1880 was the necessity which had become very apparent in the State Land Office of giving the State surveyors some education in regard to the method of platting villages. In fact, the need of such instruction at that time seemed to be urgent, since it was nearly impossible to get a village map which fulfilled the requirements of the law. It may perhaps be stated that the object of improving legislation in respect to the county surveyor was also of considerable importance in the minds of

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most of the members, and doubtless contributed very much to the success of the early meetings.

The first meeting of the society was devoted principally to the discussion of matters relating to methods of land surveying. A very excellent paper was presented by Mr. J. B. Davis on this subject, which was discussed by the members present with interest. An exhibition of surveying instruments was made by four prominent manufacturers, which added much to the interest of the occasion.

At the first meeting a committee was appointed whose duty should be the preparation of a manual for surveyors' use. This committee was continued from year to year without accomplishing much of practical value, but in later years they succeeded in getting Mr. Frank Hodgman and Professor Bellows interested in the work, and they carried it to a successful conclusion.

At the second meeting of this society, Judge Cooley, of the Michigan supreme court, read his famous paper on the "Judicial Functions of Surveyors." This paper has proved to be a notable contribution to literature of its class, has been largely printed, and did much to advertise the Michigan Engineering Society.

The early reports of the meetings were very modest affairs, but were, however, profitable to the society, since the advertising proved more than enough to meet expenses of the publication. The fourth report of the proceedings was much more pretentious, and in my opinion has been the equal in every way of any report since issued. This report contained 122 pages, and was very generously printed by our past-president, Prof. Charles E. Greene, who was to be reimbursed by advertising and sales of the proceedings. The publication was perhaps rather too ambitious for the early days of the society from a financial standpoint, and it has always been the opinion of the various members that our generous president received no recompense for his time and work on this report, but on the other hand actually suffered financial loss.

The name of the society was changed to that of the Michigan Engineering Society in 1884, and the first meeting held after the change met at Lansing, Feb. 17 to 20, 1885.

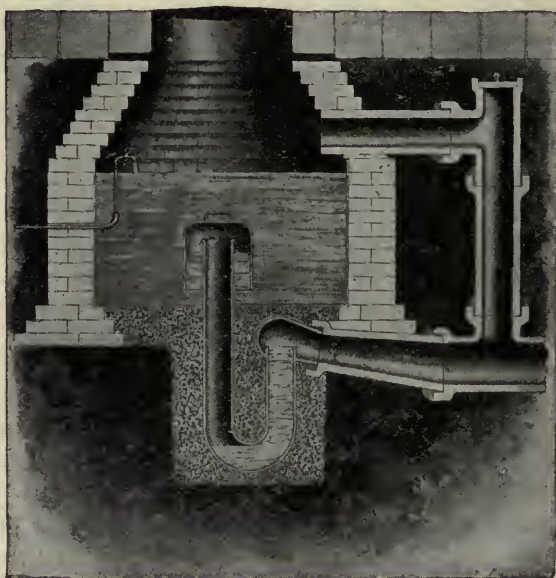
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The recapitulation of the various meetings held by the society from its organization to the present time is dull and uninteresting in comparison with the live topics of the day, and the writer will close by stating that the early proceedings of the society give full accounts of the various meetings which took place, of the officers who presided at the various meetings, of the business transactions, and the papers read, and the writer can with propriety refer to those proceedings any who require further information.

I close with the best wishes for future success, and with heartfelt regrets that I am unable to arrange my work so as to be present.

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HISTORICAL.

F. HODGMAN.

THE Michigan Engineering Society found itself at the beginning of the year 1887 in a disorganized condition. The convention met at Grand Rapids in the superior court room twelve years ago to-day. The president was not there; the secretary was absent; only one member of the executive committee (Professor Cooley) was on hand. But there were some good men there, and they went to work with a right good will. The convention proved a notable one in the history of the society, for it marked a turning-point, the beginning of a new era.

The late W. L. Coffinberry welcomed the society to the hospitalities of the city in an address full of historical reminiscences of great interest to every one present. Vice-President Steele gave an address full of practical points, which is well worth reading and heeding to-day. Among other things he suggested the incorporation of the society in order that it might have a legal standing and responsibility, and during the convention the first steps were taken in that direction. At that convention the "Manual of Land Surveying," prepared by the society's committee was first introduced to the profession. It was there that was given out the first criticism of our supreme court which later resulted in the court recalling, of its own motion, the case of Wilson vs. Hoffman, and reversing its own decision. It was there that the letter ballot for members was adopted, and there that the duties of secretary were first laid on the present incumbent. For the first year a double portion of labor fell to his portion. The preceding secretary had notified the society that the Annual Report was in the printers' hands, and would be out during the convention. As a matter of fact absolutely nothing had been done toward getting it out, unless leaving manuscript at the printing office can be so called. Not a page of copy had been prepared for the

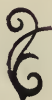


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printers, no contract let, and not a line of type had been set up. At that convention the first action was taken toward uniting with the council of engineering societies for the purpose of securing a national board of public works. It was there that J. W. Holmes first exhibited to the society his solar theodolite, a marvel of skilful workmanship and capability, but which seems to have been, like some people's beautiful furniture, to be kept in the parlor to be looked at, not used.

The 1888 convention was held at Kalamazoo, and brought out a fair attendance. Geo. E. Steele was president. Since the Grand Rapids convention he had succeeded in getting a special act of the legislature providing for the incorporation of engineering societies, and on Oct. 13, 1887, Geo. E. Steele, J. B. Davis, John J. Watkins, H. C. Pearsons, M. E. Cooley, Wm. Appleton, M. H. Bailey, R. C. Carpenter, L. G. Carpenter, and F. Hodgman met in Lansing, and adopted articles of incorporation. At Kalamazoo a constitution and by-laws were adopted, various members were admitted, and the old Michigan Engineering Society ceased to exist, and was succeeded by the present incorporated association. At that convention the criticism of the supreme court was renewed, and this brought about the reversal of the decision heretofore alluded to. At this convention was presented the first of that admirable series of papers by John H. Forster which are the delight of all who read them. It was here that a notably sharp discussion as to the value of the gradiometer took place between H. C. Pearsons and others. It was here that the connection of John Mullett with the invention of the solar compass was proclaimed to the world.

The convention of 1889 was held in Lansing in the pioneer room of the State capitol, with Geo. E. Steele as president. Various amendments were made to the constitution and by-laws, and the work of the council of engineering societies was further discussed. Among the papers read was one by Dr. Miles on Photographic Surveying. One of the attractions of the convention was an exhibition of stereopticon views by Professors Carpenter and F. S. Kedzie.

The next convention, 1890, was held in Detroit. It was held during an epidemic of la grippe. The attendance was

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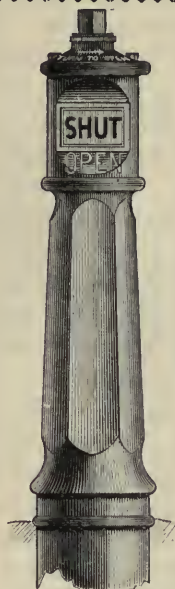
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small, and no local interest was shown, except that Walter S. Russel and F. E. Kirby furnished the hall and badges. Not more than three of the local members attended the convention at all, and only one of these took any part in its work. It was at the time of this convention that the railroad companies refused to grant the society reduced rates, except on terms with which it was impossible to comply. Professor R. C. Carpenter was president. Various amendments were made to the constitution and by-laws. The secretary was sick with la grippe all through this convention, and his chief remembrances of it are tinged with a horror of the whole thing. La grippe kept its hold on him, off and on, for more than a year, undermining and nearly destroying a once strong constitution; and at the next convention which was held in Lansing, with Professor Davis as president, the secretary was unable to be present. The road improvement question was then up for discussion, and a memoir of one of our pioneer surveyors, Robert Clark, Jr., was presented by Mr. Todd. After this meeting Professor Durand was elected president, but failed to qualify, and Professor Davis held over, and presided at the annual convention which was held in Grand Rapids in 1892. This convention was made notable and enjoyable by the special labors and courtesies of the local members, who did everything that could be wished to make it what it was,—a great success. Excursions were given to the plaster quarries and other points of interest in the vicinity, and there was a fine exhibition of instruments by Keuffel and Esser and others.

7. The convention of 1893, in accordance with a custom now well established, was held in Lansing. Colonel E. W. Muen-scher was president, and his opening address calling attention of the members to their duties and moral obligations to each other in the way of carrying on the work of the society was an admirable one, which every one of our members ought to read over again carefully and thoughtfully; for the time has come when it needs to be impressed on the minds of the members that they ought not to be simply absorbents, taking in the fruits of other men's life work and studies and giving nothing in return, but as they freely receive, so they should freely give in kind. Men do not give the fruits of years of experi-



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ence for the paltry three dollars that is paid to the society as dues. They expect, and have a right to demand, that as they have done, so shall they be done by.

The improvement of roads and road laws was the principal topic before the convention, and was very fully and ably discussed. A memorial was prepared and presented to the legislature which probably had some influence in bringing about the amendment to the State constitution.

The Convention of 1894 was held in Jackson, and was in a period of depression when it seemed almost impossible to get any one but a few of the old stand-bys to do any part of the legitimate work of the society. Less than the usual number of papers ever read, and at least one that was read might better have been omitted, as its reception led to the author's finally being dropped from membership.

The convention of 1895 was held in Lansing, with President Geo. S. Pierson in the chair part of the time. This was the first convention at which the social meeting was introduced. The year was notable for the deaths of John H. Forster, Guy Carleton, F. B. Pelham, and C. B. Hyde. Mr. Forster was one of our ablest and most willing workers, while Mr. Carleton, though never active in society work, never forgot to pay his dues before they were due, and usually put in a V for good measure. A prominent feature of the convention was the papers showing that magnetic needles differ among themselves, and the reason why.

In 1896 the convention was at Saginaw, this was high tide in the history of the society, for which it was more indebted to the active, personal work of President Geo. L. Wells than to any other one thing. A large number of excellent papers was presented and discussed, and local arrangements by the Saginaw members were perfection. The secretary has to regret in connection with that convention that he ate his supper before the banquet, and was not able to avail himself of the free excursion and generous hospitality that was extended to the society.

In 1897 the convention was again in Lansing, with President Wells in the chair. One day's meeting was held at the Agricultural College, and the social meeting was made more

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pleasurable by the addition of music and the presence of ladies.

The 1898 convention was held in Port Huron, the home of President F. F. Rogers. It was not so large as the previous convention, but was a thoroughly enjoyable and profitable one; among the pleasures was a trip through the tunnel by electric light.

In this hasty review of the history of the society since I became secretary, I have said but little about the papers presented. Adequately to discuss them would take the whole time of this convention. I will merely call to your attention some of the subjects which have been treated:—

On Land Surveying and kindred topics there have been papers by Judges Cooley, Hooker, and Montague, H. D. Bartholomew, F. and S. C. Hodgman, Geo. E. Steele, A. J. Teed, Professor Davis, H. G. Pearsons, John J. Watkins, Dorr Skeels, H. G. Rothwell, J. E. Sherman, I. H. Leavenworth, Isaac Teller, R. C. Carpenter, O. H. Todd, F. L. Church, Thos. Campau, and others, to say nothing of the Manual of Land Surveying prepared by its committee, and a digest of legal decisions for the past ten years.

On Bridges, we have had papers by Prof. C. E. Greene, and Messrs. Mason, Treadwell, Sears, Gillette, Douglass, La Rue, Vedder, Barington, and Duncan.

Waterworks and Sewerage have been treated by G. W. Pearsons, G. S. Pierson, Coats, Appleton, Granville, Greene, Gillette, Wells, Williams, Hazen, Ames, Riggs, Rogers, and Barrally.

But I can not classify the various topics treated, in the brief time I may occupy. A partial list of them includes Land Surveys, Railroad Surveys, Construction and Maintenance, Easement Curves, Photographic Surveying, Hydrographic Surveying, Plats, Map Drawing, Road Laws, Road Location and Construction, Bridge Works, Waterworks, Sewerage, Street Railways, Electrolysis, Irrigation, Drainage and Drain Laws, Cements and Cement Tests, Great Lake Levels, Earthwork Computation, Forestry and Forest Economy, Riparian Rights, Rights by Possession, Photographing, Preservation of Timber, Salt Making, Contract and Day Labor, Curb and Sidewalk Grades, Materials for Street Pav-

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ADVANTAGES OF ENGINEERING SOCIETIES.

E. W. MUENSCHER.

WHEN the statesman from Texas, in the Republican National Convention, asked the momentous question which has made his name famous, "What are we here for?" he struck a chord which vibrated sympathetically in every breast in that convention. They all knew what they were there for, and were all of one mind. So if the same question were asked here to-day, I doubt not that our reply would be equally unanimous, though I trust much more unselfish.

The great objects of engineering associations are social enjoyment and professional improvement, and the more perfectly they accomplish these objects, the greater are the advantages which they offer to their members since the declaration of the Almighty in the Garden of Eden that it is not good for man to be alone, the social instinct has been the most powerful influence for good or evil. While in all ages there have been anchorites who shunned the society of their fellows, the great mass of mankind pine and wither in solitude. It is this instinct primarily that has led to the tremendous growth of purely social and fraternal societies during the century that is now closing, and especially during the last decade. From such powerful organizations as the Free Masons and Odd Fellows down to the humblest local body, they count their numbers in the United States by scores and their membership by more than five million. The same tendency is shown in the growth of purely technical societies. Nearly every profession and trade requiring technical knowledge has now its national and local organizations for the advancement of its peculiar interests. The engineering profession has been among the first in this work. Indeed, in no other profession is there so crying a necessity for it. The members of most other professions, such as the law, medicine, or divinity, are usually gathered in groups of greater or less size in each community, where they can enjoy the benefits of frequent social intercourse, and the

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intellectual spur and discipline of generous rivalry, while surveyors and engineers are widely scattered, often but a single one in a village, or on the vast plains or mountains of the West, where they have no opportunity to confer with their professional brethren, and are specially liable to fall into a rut, to lose track of what is going on in the engineering world, and either fail to see that they are falling behind in the race or become disheartened at their lack of opportunities for improvement. To them of all others it is a special treat to leave behind them for a time the cares and anxieties against which they have struggled alone, and the lack of interest and appreciation of their work which is too often their lot, and even for a few brief hours to look into kindred faces; to listen to cordial greetings, and feel the clasp of friendly hands; to tell the story of their difficulties and their triumphs; to mingle with those who have tastes and pursuits similar to their own, and who can sympathize with them because they have met and conquered the same or similar difficulties themselves; to ask for counsel from men who are older and more experienced than themselves, or perhaps lend a helping hand or a word of encouragement to some younger or less fortunate brother.

The American Society of Civil Engineers, the mother of engineering associations in this country, dates only from 1852, but now numbers about 2,200 members. The unavoidable subdivision of the vast field of engineering science has caused the formation of other national societies covering special fields; such as, the Electrical, Mining, and Mechanical Engineers, the Master Mechanics and Roadmasters, the Water-Works Association, and others which number their members by thousands. The value of these great societies can hardly be overestimated, but the expense attending their membership and the magnificent distances over which the profession in this country is scattered, and which make it impossible for the great mass to attend their meetings, has led to the formation of numerous local associations, like the Michigan Engineering Society, which now number nearly forty in the United States and Canada. Some of these are devoted to specialties, but the majority cover the entire field of engineering. To some one of them is united nearly every man in our profession who is of

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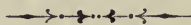
the slightest value. Indeed, it is almost suicidal for any man who has the slightest desire to rise in his profession to keep out of them. There was once a time within the memory of many of us when a trained civil engineer was a *para-avis*. Training-schools were few, and but poorly equipped, the demand greatly exceeded the supply, and any man who had intelligence enough to learn to look through the right end of a telescope, and to perform a few simple operations in arithmetic and trigonometry, was eligible for employment in a railroad party, and with a Hencks Field Book in his pocket could proudly assume the title of civil engineer. A few of these rule-of-thumb engineers still survive, and some of them by the force of native talent and hard work have risen to high position and deserved fame; but their day is fast passing away. Our numerous engineering schools are now turning out annually scores of bright young men well grounded in mathematics and the fundamental theories and principles of physical science, and prepared, after a few years of practical experience, to push the slow-going old-timers off their stools. The man who in these days starts out to be an engineer without such training, is heavily handicapped at the outset, and has hardly one chance in a hundred of success. And even the man who has that training must not trust to that alone. If he stands still for a moment, he drops behind, and can recover his position only by increased labor. The world has no mercy on the laggard, and in his case the price of success is eternal vigilance. In no other profession is prosperity or even existence so dependent upon success. The physician can hide his mistakes under the sod, and excuse himself by the plea that all men must die, and the case had become hopeless before he was called. The unsuccessful lawyer can claim that one side of every lawsuit must lose, and it was the ignorance or prejudice of the jury which made him the loser. The clergyman who can not please a city parish may find some niche in the rural districts that he will fit, and judiciously adapt his teachings to the pulses of his hearers. But the engineer has no such refuge. He must succeed or quit. The laws of nature are positive and immutable, and he must understand how to apply them or cease his pretensions. Let a single bridge of his designing go down, and

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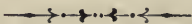
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his reputation as a bridge-builder is gone. The interests entrusted to engineers, are often so vast, and the losses that may result from their failures so serious, that capitalists will not tolerate such failures, or the men that make them.

The advance of engineering theory and practice has been so rapid of late years that it is difficult for even the most diligent scholar to keep pace with it, and he who fails to do so will soon find himself left behind in the race, and he must be content with the more humble prizes which the profession offers, or retire entirely. Entire branches of engineering science, like that of electrical engineering, have been almost wholly created in the last decade. In other lines, like the purification of water and sewage, great progress has been made. Text-books can not keep up with this progress, as new editions would be required almost every year, and few engineers could afford to buy them all. While the fundamental principles of our profession are immutable, and are embodied in books which every engineer should possess, it is in the practical application of these principles, either to new objects or in improved methods, that the advance is made. These new ideas are almost invariably first made known to some scientific society. They come one by one, and the men who discover them seldom care to write a whole volume to exploit them. But from a creditable ambition either to benefit their professional brethren or to receive the first credit and honor due to their discoveries, they embody them in papers before their societies. Here the search-light of criticism is turned upon them, their errors exposed, their defects supplied, their limitations defined, and the chaff separated from the wheat. Often the discussions of a paper are more valuable than the paper itself. In the end, the kernel that is left finds its way in a condensed form into a text-book, but in the meantime the society member who has read the paper has received hints which have helped him in his work, or perhaps put him on the track of new and creditable discoveries of his own. The great object of engineering societies is the collection and publication to the world of this new information, and in this way they are accomplishing a vast amount of good. While there is no disposition on their part to conceal their treasures, it is natural that those who help pay their expenses should receive their greatest favors.

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But engineering societies do not confine their benefits to the enjoyment of the fruits of other men's labors. They give each member an opportunity to show what is in himself. If a new idea occurs to him, a society paper will be his best medium of publication; and he can be sure that if it is of any value, he will receive due credit for it from those who are best able to appreciate it. And even though such a paper should bring no special credit, or embody no very new or startling discovery, the mere act of preparing it is a valuable discipline to the writer. Nothing serves so effectually to arrange and systematize a man's knowledge, to clear up doubts, to expose deficiencies, and to impress it thoroughly on his own mind, as the attempt to put it on paper. Even though it be only a compilation, and be laid aside when completed, he will have clearer and more definite ideas, and if published he may have at least the satisfaction of thinking that possibly he may have lightened the labor of some less fortunate or less-informed brother.

While there are many and great advantages attending membership in the great national organizations, yet in either the social or the economical point of view, the great majority of engineers can receive more benefit from the more humble local societies like this of ours. They are within our reach, they discuss topics connected with our local interests, they bring together men who may often have opportunities to help each other, and they offer at a small cost as much valuable literature as the great societies furnish at five times the cost. Indeed, I can not help thinking that the Michigan engineer or surveyor who refuses or neglects to avail himself of the benefits which this society offers him at so trifling a cost, is either too unambitious of improvement or of too little consequence in the world to deserve any of our sympathy; and I feel disposed to call down upon his head the sad fate predicted in the hard-shell scriptures, "For he shall gnaw a file, and flee to the mountains of Hepsidam, where the lion roareth, and the whang-doodle mourneth for his first-born."

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PAPERS READ AT THE TWENTIETH ANNUAL CONVENTION, LANSING, MICH., JAN. 24, 25, 1898.

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CHAS. E. GREENE.

AT the convention, when I last had the honor of occupying this chair, I inaugurated the custom of an annual address by the president. After sixteen years I fall a victim to that precedent myself, and shall endeavor, at this late date, to offer some compensation for the length of my paper on that occasion, by a becoming brevity now.

It appears to me that the gentlemen who call this convention the twentieth anniversary of the first organization of this society figure much as do those persons who insist that the twentieth century begins next year; but no matter, this is as good and fitting an occasion as one could desire for reviewing the past, rejoicing over the present, and looking forward with hope into the future.

I have proposed to call to your attention the progress that has been made in engineering during the past nineteen years, and, as the field is too large to be well covered in the time which is at my disposal, I will confine myself to enterprises and developments in this country.

The year 1880, in which this society was organized, was one of great activity in engineering, and railroad construction then offered many opportunities for employment. The Atchison, Topeka, and Santa Fé R. R., the Southern Pacific, the Northern Pacific, and the Canadian Pacific Railways were being surveyed, and actively pushed across the territories. The West

Shore R. R. was begun, and numerous shorter lines were under construction. Narrow-gauge railroads still had many friends. To-day we hear nothing of different gauges. Narrow tracks have been widened, and the wide-gauge roads have been narrowed to the standard. At present, railroad location and construction occupy a comparatively insignificant place among engineering activities. Other classes of enterprises have opened better avenues for the employment of the engineer. Among them municipal improvements, structural steel work, and the varied applications of electricity come to mind.

Let us note some of the undertakings which were inaugurated in 1880, or were approaching completion.

The Washington monument was then beginning to rise above the moderate height of 156 ft., which it had attained in 1859, and had just been boldly underpinned with a deep concrete foundation. The obelisk had been successfully transported from Egypt, and erected in Central Park, New York. The Memphis sewers, which gave new health to that disease-smitten city, and brought prominently into notice the advantages of the separate system of sewerage, were completed in that year, from plans of Colonel Waring, who has recently fallen a sacrifice to yellow fever, contracted during an official visit to Havana for the purpose of reporting on the best sanitary measures to be adopted in the latter city. The Hudson River tunnel had been begun; when it may be pushed to completion no one can say. The East River bridge was well under way. The Eads jetties at the south pass were nearly finished, and were silencing criticism of that plan for improving the mouth of the Mississippi. The town of Pullman was in process of development; to-day it is passing out of private control.

The great United States testing-machine had recently been installed at Watertown, Mass. Blasting at Hell Gate was in progress. Steel as a substitute for wrought iron in bridge work was somewhat timidly being introduced. The material of the Grand Trunk suspension bridge trusses at Niagara Falls was changed from wood to iron. The survey of the Panama Canal by De Lesseps was made, and excavation started soon after. The Westinghouse automatic air-brake had been adopted on quite a number of railroads in the United States. The Platts-

mouth bridge was built. Water-works had been introduced into some five hundred and seventy cities, large and small, in the United States and Canada. In 1898 there were about 3,350 complete plants supplying more than that number of towns, and of these plants, some 1,400 were built in 1897.

Fifty-six and sixty-pound rails were standard weights for railroads. Stub switches were in common use on main lines. Loads of 2,000 to 2,500 lbs. per foot of track were still used in designing railroad bridges. The price of steel rails was \$62.50 per ton; of iron rails, \$47 to \$50; of pig iron, \$28 per ton; and structural shapes in iron were quoted at 2.7 cents; beams 3.1 cents per lb.

The Brush system of electric lighting, Edison's electric lamp, the Bell and Edison telephones, had made their appearance, but had not ceased to be looked upon as novelties.

Since the lower peninsula of the State of Michigan does not place in the path of the engineer such formidable obstacles as are encountered in other parts of our country, he has not been called upon to carry out many notable works to overcome them. But in the construction of water-works, sewerage, brick and asphalt paving and municipal improvements, members of our society have been actively and creditably engaged.

The Port Huron tunnel is a piece of work which is most highly creditable to the engineers who so ably laid the plans, designed the shield, and carried out the construction without accident or delay.

The new United States lock at the Sault, begun in 1886, is a notable example of a first-class masonry lock of the largest size, 800 ft. long, 100 ft. wide, 43½ ft. high, with 21 ft. of water on the miter sills, with curved metal gates, and ingenious hydraulic operating machinery, all planned, built, and installed with the greatest care. The Canadian lock, begun in 1889, 900 ft. long and 60 ft. wide, and with wooden gates, was built in a remarkably short space of time for a work of that magnitude, and is the first lock where the gates are operated by means of electricity.

The increase in size of the steamers and consorts which traverse the Great Lakes, and the change from wooden to

steel hulls are noteworthy. The increase in freight tonnage passing through the St. Mary's Falls canal, from one and one-half million tons per year in 1881 to eighteen million tons in 1897 is remarkable. The deepening of the navigable channels in the lakes and connecting rivers to twenty feet has made possible this increase in size of vessels and in tonnage carried.

The whaleback, of great carrying capacity, was designed but a few years ago, but it is doubtful whether this type of craft is to survive.

The ice-breaking ferry steamer at the Straits of Mackinac has rendered it possible to keep communication open, and to transfer merchandise in cars throughout the year to and from the upper peninsula. That ice-breaker has been thought worthy of careful examination by foreign officials charged with designing similar steamers for the Baltic Sea.

The transfer steamers in use between various harbors on Lake Michigan have enabled the railroads interested in those ports to carry on a heavy freight business without breaking bulk, and practically throughout the year.

The Milwaukee water-works tunnel, not long since pushed to completion, through and around what seemed to be insurmountable obstacles, is a marked example of engineering skill and pluck.

The water tunnels, which have been laboriously dug and blasted at Chicago, four miles or more out under the bed of Lake Michigan, for a pure and healthful water-supply, have not attained that object, as the city in its rapid growth poured increasing quantities of sewage into the lake. The Chicago drainage canal has not only been constructed for diverting this sewage from Lake Michigan to the Illinois River and thence to the Mississippi, but has also been planned for a possible ship canal; and it is a most brilliant example of modern engineering methods, and of the good judgment and energy of contractors in handling enormous quantities of material,—mud, gravel, rock, and obstinate hard-pan, with great rapidity at extremely low prices. Dredges, steam excavators, power drills, high explosives, power scrapers, endless chain conveyers, cableways, derricks, cantilevers, etc., were devised and used with great success. The different ways and contrivances

for handling the materials excavated have been described in the technical press.

The canal is twenty-eight miles long ; was put under contract in 1892 ; has a prism 160 ft. wide in rock with vertical sides ; in earth 202 ft. wide on the bottom, with slopes 2 to 1 ; its depth is 26 ft. below the water line, and the calculated flow is 600,000 cubic feet per minute. The Des Plaines River has also been diverted from its former channel for a considerable distance. There were 40,000,000 cubic yards of excavation, and the cost was \$28,400,000.

In speaking of Chicago one naturally thinks of that wonderful creation of the architect and engineer, the World's Columbian Exposition, which arose in its beauty almost in a night, and which vanished all too soon ; as so many of us saw it, and its photographs have been widely distributed, no detailed description will be attempted.

The new Congressional Library, at Washington, the pride of the country and the admiration of all visitors, native or foreign, is a proper subject for comment. It has been planned and built with the greatest care under the charge of members of our profession ; it was completed in the estimated time and within the estimate of cost. The same engineers completed the Washington monument.

The modern high building originated in Chicago, and thence has been introduced in Eastern and Western cities. In such buildings a carefully planned steel skeleton is clothed with a comparatively light covering of stone, brick, and terra-cotta. Land of high value per square foot in business centers can be made to return an adequate rental when supporting a structure from twelve to twenty stories high. In these the necessary thickness of walls without the steel frame, would be prohibitory.

The problems arising in carrying the loads on the foundations and distributing the pressure call for the best energies of engineers in their solution, and the design of the structural steel work gives employment to many of our profession. In New York, methods of founding on the deep-lying rock through the superincumbent clay have been employed which are much like those used for bridge foundations, including caissons with compressed air.

The question has been raised as to the ability of such high structures to resist earthquakes, and has been answered by the Spreckels building in San Francisco, which was designed for such a contingency, and has successfully passed through the experience.

The upper stories of such lofty buildings are made of nearly equal value with the lower ones by modern high-speed elevators of most creditable design — indeed the facts that better light and less noise and dust are to be had in the upper stories may weigh decidedly in their favor. The planning and installation of the boilers and plant for heating, lighting, ventilating, and sewerage such structures furnish other opportunities for engineering talent to make itself felt.

Modern steel bridge construction tends more and more toward definiteness and simplicity in design. Loads on railroad bridges, nearly double those that were thought necessary twenty years ago, call for more massive proportions. The effect of impact is allowed for. Increased stiffness in bracing and directness in connections are to be found; many of the details once used are not now considered good practice; and modern designs agree more and more closely with the teachings of theory. Solid floors are becoming common in first-class construction, making a roadway like that on the approaches; and the plate girder is used for longer and longer spans.

Methods of bridge erection and replacement without interruption of traffic have been remarkably developed in recent years, so that the substitution of one bridge for another has become a matter of days, or even hours, where once weeks or months were consumed.

The Roebling suspension bridge at Niagara Falls, after its trusses had been changed from wood to iron, as mentioned in the early part of this paper, and then its stone towers had been replaced by steel ones, has but just now been superseded by a fine, steel braced arch carrying a double track for the Grand Trunk Railway, as well as a roadway for vehicles. These successive changes have been made by the same engineer, with practically no interruption to the railroad business.

The light highway suspension bridge below the Falls, first designed for a single line of pleasure travel, has just been

replaced by a handsome two-hinged steel arch, of 840 ft. span, the longest arch span in the world.

The tubular bridge at Montreal, the only example of its kind in this country, has disappeared the past year, having been replaced, without material delay of trains, by modern trusses, designed to carry more tracks and a greater load.

The construction of the Niagara cantilever in 1883 brought into more prominent notice, than had the erection of the Kentucky River bridge, the advantages offered by such designs for spanning large openings, avoiding the introduction of material rendered necessary by the uncertainties of the continuous girder, and permitting the easy erection of trusses where false-works could not be used. Hence the cantilever principle has been introduced in numerous modern bridges of large span.

Ingenious designs for movable spans have been brought forward in recent years. Lift bridges, balanced draws, rolling bascule draws, and other types have been illustrated in the technical press.

The safety of travel by rail and by highway has necessitated the separation of grades at city crossings, while some first-class railroads in the Eastern States have found it expedient to do away with grade crossings for many miles of their lines. Much expensive work of an interesting nature in steel and masonry as well as in the way of embankments has been done in recent years. The problems arising are often complicated; the pecuniary outlay is very large; but it has been in the interest of true economy. Track elevation is making rapid progress in Chicago.

The use of concrete has greatly increased, for foundations of structures, for arches, for fire-proof floors, for foundation for street paving, for entire structures. The manufacture of cement, more especially of Portland cement, in this country has been stimulated, and Michigan bids fair to become soon a large producer of an excellent cement.

The output of steel has increased to a wonderful degree; the low price at which it can be produced, the excellence of the material, have caused it to take the place of wrought iron in the arts. Steel castings can now be made of great strength and toughness and satisfactorily sound. Molten iron has been

carried by rail in ladle cars five miles, from the blast furnace to the steel mills. The prices now are, steel-rails \$18 to \$20 per ton. Pig iron \$10 to \$12. Beams 1.2c to 1.5c per lb. Angles 1.1c to 1.2c. I beams 24 in. deep are now rolled.

The manufacture of armor plate in this country was but recently established. The Bethlehem Iron Works obtained their first contract from the U. S. government in 1887, erected a large and expensive plant, and made and delivered 6,400 tons of armor plate on that contract by 1895. In that year they also shipped armor plate to Russia. Previous to the establishment of this plant our government had imported its armor plate from Europe. Carnegie obtained a contract for 6,000 tons in 1890, and completed it by 1895, together with another contract made in 1893.

Harveyized steel and Harveyized nickel-steel plates are turned out. The machinery required to produce ingots and handle plates 15 to 18 in. thick, over 125 sq. ft. in area, must be very powerful. The driving and blowing engines and hydraulic presses and plant are most creditable to American engineers.

Armor-piercing projectiles, the use of modern high explosives, smokeless powder, Maxim guns, rapid-fire ordnance, built-up guns, disappearing gun-carriages in concrete gun emplacements, are some of the noteworthy attainments of recent years.

The weight of steel rails has increased to 80 and 100 lbs. per yard for standard track, and they can now be rolled 60 ft. long. The girder rail for street railways is a modern section.

The use of 60-inch riveted steel pipes for conveying water, the construction of standpipes or water towers of diameters up to 75 feet, the design and erection of lofty telescoping gas holders 170 ft. in diameter, 160 ft. high from bottom of tank, the introduction of steel cylinders in groups for the storage of grain are noteworthy examples of modern progress.

Recent events have made it unnecessary to do more than call attention to the development of our navy,—battle-ships, cruisers, and torpedo-boats,—all designed and built in this country, and fitted with engines, pumps, electric and other machinery in profusion.

Higher pressures of steam are now carried, and triple, if not quadruple expansion engines are built. The compound locomotive has found favor, the steam-pressure has reached 180 lbs., if not more, and express speeds of a mile a minute, are not uncommon. For single miles, speeds of 100 or 110 miles per hour have been made. Steam from the locomotive has displaced the stove for car heating.

To do away with the labor of handling the enormous quantities of fuel used by modern boiler plants, coal handling and conveying machinery and automatic stokers have been devised.

I read a note in a recent technical journal which ran as follows:—

“Three Parsons steam turbines, of 500 H. P. each, are to be built by the Westinghouse Machine Co. to replace ordinary steam-engines. Each turbine will drive a 300 K. W. generator, furnishing current for electric lighting and for driving the Tesla motors in the Westinghouse Air Brake Co.’s shops at Wilmerding, Pa. The Machine Co. is also building a 2,500 H. P. turbine for the United Electric Light and Power Co., of New York, the first of five of the same size. Each turbine will drive a 1,500 K. W. multiphase generator. The five engines and generators, 12,500 H. P., can be put in about one half the space now occupied by eight vertical Westinghouse engines of 1,200 H. P. each, with Westinghouse generators.”

How many new inventions are grouped in one short paragraph! Westinghouse engines, steam turbines, Tesla motors, multiphase generators, electric light and power, with other implied auxiliaries, and all on an astonishing scale.

The development of applications of the electric current may well excite our wonder. A new and extensive field for engineering talent and invention has been opened in recent years. Electric lights, both arc and incandescent, have come into common use. The local telephone is a business necessity and a household convenience; the long-distance telephone almost supplants the telegraph and annihilates distance. Electricity has banished the horse from our street railways, has superseded his successor, the cable, and is rendering interurban communication along our highways, for distances of many miles, rapid and comfortable.

By its means power is conveyed to a distance, from points where water power affords a cheap means for the conversion of energy, or fuel is abundant, to other points where the electric current is subdivided at will, to drive machinery for all kinds of manufacturing industry. The great plants installed at Niagara Falls are noteworthy instances of this kind.

By the aid of electricity chemical reactions are possible, which, for example, produce aluminum at so low a price that a comparatively new metal has become available in the arts — where its lightness and freedom from oxidation are of value — and carborundum which displaces emery for grinding.

I ought to mention the work done at the Lawrence experiment station, in investigations on the filtration of water and sewage, the increased attention paid to sewage purification and disposal, the covering of reservoirs, wooden-stave pipe, the application of the air lift to driven wells, the Venturi meter, the New Croton aqueduct for New York, the Metropolitan water-supply of Boston, the intercepting sewer system for the same city, and the Metropolitan sewer system for all the cities adjacent to Boston.

Then naturally comes to mind the Boston subway for street-cars, just completed, which relieves the crowded condition of several of that city's streets, elevated railroads built in several cities, boulevards and parkways which bear witness to the skill of the landscape architect and the engineer.

I can only allude to the Pelton water-wheel and other motors of its type, to the modern high-duty pumps, which have been found to attain one hundred and forty million foot-pounds, to the wood pulp manufacture, both by grinding and the sulphite process, to the freezing process for working in quicksand, to artificial refrigeration, to motor carriages, to the use of compressed air.

I might speak of Western irrigation projects, of the powerful dredges built for work on the Mississippi River, of the improvements carried out by the Mississippi River Commission, of the American types of movable dams, of the great dry dock at Puget Sound, but I must bring these remarks to a close and I will only add,— if such has been the progress in a score of years what may we not expect of the years to come.

WATER WASTE IN THE WATER-WORKS PLANTS, AND ITS PREVENTION.

A. L. HOLMES, GRAND RAPIDS, MICH.

I HAVE been assigned the topic of Waste, and as it pertains to water waste, the subject can not be a dry one, no matter how tedious I may become.

I will endeavor to treat this subject from a simple economic standpoint, and will attempt to base my assertions on a plain business foundation. From this standpoint, any unnecessary use is waste; all beyond that which is needed is dead loss.

Amount Needed.—Naturally, then, the first thing to be ascertained is this: What are the needs of the water consumer? Taking the average family of five persons living in a modern house, having a lawn of say 2,000 square feet, and hot and cold water bath, closet, and laundry, I would place the uses of water as follows: bath, twenty-five gallons; drinking, five gallons; cooking, ten gallons; closet, twenty gallons; laundry and dish-washing, thirty gallons; or a total daily use of ninety gallons for the domestic uses of the five persons.

If the lawn be wet one hundred times during the year, which is in my opinion a liberal allowance, 375 gallons of water will be used each time. This will bring the total consumption of water for this family up to about 70,000 gallons per year, or a per capita daily consumption of thirty-eight gallons. This amount of water is worth to that family just what it costs to deliver it to them. In my home city they would pay on a flat or schedule rate \$16 per year, and the meter rate would be \$8.75. I think this estimation of *use* is fair and economic.

Experience of Other Cities.—What has been the experience of cities, and what has been shown to be the quantity of water needed for legitimate use? This question is often asked. From experience and much investigation of the subject, measuring

the amounts used in actual services, has been found the amount necessary to be supplied for a city service. Then taking the amount used for public services into consideration, together with the amount actually pumped, we can draw our conclusions as to the amount wasted.

Taking the results of all experiences, it has been found that for all purposes for which water is used from a city plant, fifty gallons a day per capita is the maximum allowance; and in order that this amount should be used, it is necessary that the buildings should be plumbed for all the modern conveniences, with sewer connections, and the water sufficiently pure to allow of its use for all the domestic purposes of life. Under these conditions a family of five *might* use seventy-five gallons per day; the balance is left to be accounted for in manufacturing, fire service, sewer flushing, lawn and street sprinkling, fountains, watering troughs, and other uses of a public nature.

We find that in those cities where stringent and effective measures have been taken to prevent waste, the amount furnished is much less than the figures that I have given, and my personal experiences show that this amount is a very liberal one. In the smaller cities where there are but few manufacturing establishments using water from the city's mains, the amounts will be found to be much less.

In our pumping plants the custom of taking the revolution counter as a record of the amount pumped is liable in many cases to mislead as to the amount *actually* delivered into the mains, and, in many of the smaller plants even that means of determining the amount is lacking, and there is no practical way to ascertain the amount supplied through the pumps to the mains.

In those plants having stand-pipes, reservoirs, or elevated tanks, a very close estimate can be made, much more accurate than by taking the record of the revolution counter; however, a competent man in charge of a water-works plant can always find *some* way to ascertain the amount pumped daily. He can also form a pretty accurate judgment of the amount used and of that that is wasted.

The following is a list taken somewhat at random from all over the United States, showing the per capita daily use of water :—

	Population.	Gallons Used.
Battle Creek, Mich.....	16,000	37
Madison, Wis.....	18,000	50
Bayonne, N. J.....	25,000	27
Boone, Ia.....	10,000	35
Danville, Va.....	13,000	42
Fall River, Mass.....	97,000	37
Harrisburg, Pa.....	50,000	85
Highland Park, Ill.....	3,000	50
Lowell, Mass.....	85,000	80
Montgomery, Ala.....	30,000	83
New Rochelle, N. Y.....	10,000	25
Newton, Mass.....	28,500	63
Pawtucket, R. I.....	33,000	72
Providence, R. I.....	145,000	57
Rochester, N. Y.....	170,000	63
St. Paul, Minn.....	150,000	60
Syracuse, N. Y.....	120,000	61
Tarrytown, N. Y.....	4,000	75
Washington C. H., O.....	7,000	60
Yonkers, N. Y.....	38,000	85
Aurora, Ill.....	25,000	40
Irvington, N. Y.....	3,000	15
Kansas City, Mo.....	150,000	60
Alameda, Cal.....	15,000	40
Atlanta, Ga.....	100,000	60

This list of cities could be extended almost indefinitely, but I think that I have instanced enough to show that the claim I make is well founded on the facts in the case.

Leaks in Mains.—After the water leaves the pumps under pressure, the first waste that is encountered is leaky joints in the mains. These may be small, but the amount wasted in the aggregate may be large.

This is very forcibly shown in a new plant having a stand-pipe and no services in use. The pressure gauge of such a plant will show a diminishing pressure each day. I am supposing that the stand-pipe is filled, and the pumps stopped.

Concrete Base for Pavements.—The now prevalent custom of using a concrete base for street paving in our cities is going

to seal many of these leaks from sight, and if the sewers are in close proximity to the mains these leaks may grow to be serious before they are discovered. It is of great importance that all mains in streets about to be paved with a pavement that requires a concrete foundation, be thoroughly tested before the pavement is laid, and the mains closed from sight.

Corporation Cocks.—The now about out-of-date tap, made with tapering sides and no threads, in general use when pressures were much lower than now, has wasted a good deal of water in its day, and it should be put out of service wherever it is used. Nothing but the best corporation cocks made should be used or allowed in the mains.

Service-pipes.—The service-pipes in many plants are of wrought black pipe, and soon become leaky at the joints. Connections with the yard hydrant and outside and underground fixtures, in sandy and gravelly soil, may leak a considerable amount of water, and escape notice for a long time.

The prevalent custom of licensing plumbers to take the service from the main to the property line, is, in my opinion, wrong, and is the cause of much poor work. The city or water company should furnish all material, and run all services, from the main to the property line, placing a stop-cock and box at the curb. The city should inspect, and insist on the best pipe and workmanship being used from the curb-box to the inside of the building, and proper provision made for the placing of a meter. Better material and work can be secured in this way than from contract work by the plumber.

Leaky fire hydrants cause but little waste, as from the nature of the service immediate repairs are demanded.

Public watering troughs use much more water than is necessary. I find but few that are equipped with automatic closing devices. The continual flow of water wastes perhaps one hundred times as much as is used by the animals that it is supposed to accommodate. This is entirely unnecessary, and the least that could be done with this water that runs to waste would be to have it run into automatic flush tanks to flush the sewers. In this way some small benefit would be derived from this wasted water.

Automatic Flush Tanks.—Automatic flush tanks in public places, like railroad-station urinals, at hotels, and in connection with sanitary sewers as managed in many places, are a source of enormous waste, which is occasioned either by carelessness of the parties in charge or defective fixtures.

Submerged Pipe.—All submerged pipes should be regarded with suspicion. Frequent tests and inspections should be made, so as to be certain that pipes crossing rivers and other bodies of water are tight. This work should be done in as thorough a manner as possible, by experienced men in that line, and the very best material used. It is very liable to settle and move, and dangerous leaks develop, which, from the location, will escape notice unless diligently searched for.

Private Lines to Factories.—Many cities allow manufacturing establishments to run large mains into their property, with fire hydrants attached to be used for fire service only. In a large number of cases these lines supply tanks holding water for automatic sprinkler systems; but it will generally be found that water is used for other purposes, and as the most of these factories are located on filled ground and adjacent to bodies of water, leaks easily escape notice. Where water for drinking or sanitary purposes is taken by these concerns, irresponsible employees are the cause of much waste.

Causes of Waste in House Services.—The principal causes of waste in house services are the hopper closet, urinals that are constructed for a constant flow, lawn-sprinkling, and poor plumbing—pipes that are unprotected from frost so that it is necessary to allow a continuous flow of water in freezing weather.

Hopper Closets.—The hopper closet is perhaps the worst of these contrivances, and each one that is allowed to be installed will waste as much water daily as will be legitimately used by a dozen families. They are generally placed in basements and cellars where the pressure is the greatest, most likely in some dark and unventilated corner, where the constant flow of water is popularly supposed to keep back the dreaded sewer-gas. Where this closet is used, the plumbing is often bad, as the only excuse for its use is its cheapness in price.

Constant Flow to Prevent Freezing.—In factories, stores, and tenement buildings, many of the so-called sanitary closets are so placed that the only safety from freezing is in a constant flow of water. Tank closets are often found with a weight attached to the tripping chain to secure exemption from the effects of cold weather. Rigid inspection shows that about every third house is wasting water through leaky fixtures.

Boston Investigations.—The result of investigation in the use of thirteen hopper closets in the city of Boston, has shown that there passed through them on an average 874 gallons daily; and when tank closets were substituted, the same service used 189 gallons daily, or a daily saving of 685 gallons of water each.

Sprinkling.—The abuse of the lawn-sprinkling privileges causes the waste of large quantities of water by the common practice of allowing the hose to lie in the grass without a nozzle, thus flooding the ground. The amount of water necessary for an ordinary city lot is not large, and if used only as necessary, this item would not cut the figure that it now does in hot weather. If lawn-sprinkling was allowed only while the hose was held in the hand, this waste would drop to a minimum. Many cities have made and rigidly enforced this rule.

Cooling Vegetables.—In several towns, pumping from wells with but a limited supply for domestic purposes, and with a strong demand for more and larger pumping machinery, I have found several parties continually running water from the city mains through shallow vats, in which were set dishes containing milk, butter, and vegetables, keeping these things cool and fresh, and saving the cost of ice. These parties were not detected by the inspector, and the practice was discovered by accident.

Kitchen Faucet.—It is a common practice to allow the kitchen faucet to remain open, and the water running during the summer months to procure cold water. This is a great waste, and is without reason, as the service-pipe holds not to exceed a couple of gallons from the faucet to the main; this is soon emptied, and then as cool water as the main affords is obtained, so that the continual flow is only waste.

Water Motors.—The water motor is also a great waster of the supply, and the increasing use of this device will prove a costly matter to the water-works. No flat rate for this service should be made until it is found how much water is used in their operation; for instance, a motor in Hartford City, Ind., used to operate a cash-carrier system and a set of cooling fans in a department store, used 20,000 gallons of water daily, for which the flat rate of \$35 yearly was charged. This rate was continued for four years at ten cents a thousand gallons. This water was worth \$600 yearly.

At Huntington, Ind., a motor running a printing-press used 75,000 gallons daily, and another on a smaller press used 28,000 gallons.

Three motors operating fans at Lafayette, Ind., used respectively 3,000, 9,700, and 9,080 gallons a day. A motor used in a butcher shop in connection with a meat-chopper, on a flat rating of one dollar a month, used 20,000 gallons a day.

The motor-man is all right in his way, but it is not in the interests of the economical use of water.

Liveries.—Liveries and sales stables waste an enormous quantity of water. The following are three examples of the amount that was used: One used 8,416, the other two 7,823 and 6,347 gallons a day, respectively. All these places were rated at a flat rate of \$1.25 a month.

Laundry.—A laundry in another town got 8,026 gallons a day, for which it paid the magnificent compensation of a dollar a month.

Restaurants rated at \$8 a year used 1,574 gallons a day, and another paying \$10 yearly used an average of 3,218 gallons daily.

School.—A public school at Terre Haute, Ind., with an attendance of about 400 pupils, having automatic flush closets, used during October, 1897, 153,000 gallons of water, and in November of the same year, 180,000 gallons. Tank closets were substituted in 1898, with the result that in October of that year there were used 25,000 gallons, and in November, 15,500 gallons. You can figure what those automatic closets cost the water company.

Richmond, Va.—Superintendent Bolling, of Richmond, Va., tells an amusing story of waste and imagination. A leak from an underground service passed under the adjacent premises, and came to light in a lot some two doors from the premises supplied. A supply pipe had been placed at this outlet, and the occupants and neighbors used the water from this *spring* for years, and pronounced it much cooler and better than the water supplied by the city. When the leaky service-pipe was repaired the *spring* dried up.

Oshkosh, Wis.—In Oshkosh, Wis., a leak in a joint in a main caused a loss of 300,000 gallons daily, which was absorbed by the sawdust with which the ground had been filled, in which the pipe laid, and made no showing on the surface.

Grand Rapids Test.—Carefully conducted tests in the city of Grand Rapids, Mich., the present season, by city engineer George M. Ames and superintendent of water-works John Van Amburg, showed a waste of about eight million gallons daily in a total pumping of fourteen million gallons, or more than fifty per cent. The high service of this city, which supplies a purely residence district, is supplied by a stand-pipe. Between the hours of 1:30 and 3 A. M., the pumps being cut off, the water in the stand-pipe settled thirty-one feet, or at the rate of nearly two million for the twenty-four hours. What became of this water? There certainly was no legitimate use for it at the hours mentioned. The only answer that can be given is, "It was waste." It costs money to pump water into stand-pipes, and the wasting of water in this instance is equivalent to wasting money.

Grand Rapids has had its experience with waste before, as will be seen from the report of the Board of Public Works for the year ending, April, 1881, the supply at that time being barely sufficient to meet the demands. Twenty-one services were found to be using 91,000 gallons daily. Close inspection followed, and several leaks were repaired. The result was that the use decreased to 7,871 gallons on the twenty-one services, and the consumer was *using* just as much water as before. The saving effected was equal to twenty-nine million gallons yearly, which at that time was equivalent to six per cent. of the entire output of the plant.

General Waste.—We find on all sides of us leaky fixtures and poor plumbing, wasting the water-supply which has been obtained at so large an expense. Unless the most stringent rules for prevention of waste and the closest inspection is inaugurated and maintained, the custom of allowing leaky fixtures to go without repairs will cause habits of wastefulness to grow upon the consumer. Soon, in consequence of this evil, the demand for water at certain periods will be greater than the works can supply. We have in the past met this condition in most cases by securing an additional water-supply, and the installation of larger pumping facilities. But our available supplies of water suitable for domestic purposes are becoming more and more difficult and costly to procure. This temporary relief, when secured by additional pumping machinery, becomes costly in repairs, maintenance, and fuel, in many cases causing an outlay equal to the original cost of the works, and all simply to provide for, and maintain, a constantly growing waste. If these wastes can be stopped, and the water used for legitimate purposes only, the most of our towns will have an ample supply with an increased pressure at all times for a long period to come.

Additional Machinery.—The use of additional machinery comes as the increase of water takers demands its introduction, or as the old wears out; so in consequence of a less amount per capita used, the lower the cost of maintaining the pumping station. Then, as a natural consequence, the rates to consumers can be lowered.

Flint, Mich., 1893 and 1897.—The record of the water-works of Flint, Mich., is certainly worthy of consideration. The plant in this city is operated under private ownership, and in 1893 it had 700 services in use, and was pumping an average of 1,409,864 gallons a day, or 2,014 gallons per tap. The fuel bill was \$3,287 a year, or \$4.69 per tap.

In 1897 this plant had 992 services in use, 886 of which were metered, and the daily pumping was 689,925 gallons; the fuel bill had fallen to \$2,240, or \$2.26 per tap; the water pumped per tap was 693 gallons, a saving of about 66 per cent. The repair account is now about one half of what it was in

1893, when the pumping plant was taxed to the danger line, and the long force main into the city was much too small.

This plant, owned by a private company and operating under a franchise, had made no profits for its stockholders, and a large outlay for new machinery and mains meant a further postponement of the day of dividends. The company bought no new mains or machinery, and to-day it has a large surplus power to be used in case of fire. The same force main is still doing duty, and is carrying less than one half the water that it was in 1893. In this city a few meters acted as *inspectors*, and caused the repair of leaky fixtures, and stopped the innumerable wastes. They restricted the *use* of water in no way, and lowered the cost to the consumer.

Water is sold so cheap in this country that a few barrels more or less cut but little figure in the monthly bill, and all can have all that is needed at a moderate price.

Hand Pumps.—Some of us have lived in situations where the water used was brought into the house by hand. Four or five pailfuls a day, or from eight to ten gallons a day, were found to be sufficient for all domestic uses, except on that much dreaded wash-day, when three times as much as usual was needed. Suppose that the good wife or mother had said, "John, bring up twenty barrels of water to-day," what *would* you have said? Yet this demand is made and answered *every* day by that uncomplaining servant, the public water-supply.

Control of Waste.—The waste water, great as it is, can be controlled in two ways:—

First, by rigid rules, absolutely enforced, with frequent and thorough inspections.

Secondly, by the sensible plan of asking the consumer to pay for the water that he uses or wastes by the one thousand gallons.

You would hardly expect that the milkman who supplies you and your neighbors with milk would allow you to help yourselves from his can at a fixed rate for the year, unless he based that rate on the value of all the milk that his can could contain. Yet I find that although both milk and water have a value, and both are measured in the same way, by the gallon,

a large proportion of the water companies do business on this basis.

In a municipal plant the first consideration is generally fire protection, and in this all citizens have a common interest. It is necessary, in order that this first requisite be always available, that the plant be kept in constant operation, so that it can also supply water to customers for other purposes. But as it is a municipal plant operated for the benefit of all, the water takers have a right to expect that water will be supplied to them at the *cost* price. Then it follows that if only one third of the water is used, and the balance is wasted, some one must pay for all; and if the plant is operated at a profit, then the *consumer* pays for all. This total waste and consumption is paid for by the consumer.

The economical person, with good plumbing and tight fixtures, pays not only for the water that *he* uses but for all that his neighbors waste. This is under that system that assesses a flat rate, and that system is unfair and unsatisfactory in every way. Not charging for the water used, but charging for the number of fixtures placed in a building, is a direct request to the water user to use all and waste all that he can. It offers an inducement for the maintenance of poor and leaky plumbing. It is nothing less than commercial dishonesty in dealing in one of the prime necessities of life.

Manner of Assessing for Water.—This manner of assessing rates is the cause of most of the waste in services, and until some plan is devised by which the consumer is held responsible for the condition of his pipes and fixtures, and charged for the amount of water passing through them, this waste will continue. This system of charging for water originated long before there was any practicable way to ascertain the amount of water used and wasted.

Inspection.—Inspection, to be of use in stopping waste, must be frequent. If it is frequent, it is expensive, and also annoying to the householder; and the frequent visits of the water inspector becomes a nuisance to the lady of the house, so that she soon learns how to outwit him and continue the waste. People *will* waste water, and refuse to make repairs to their

defective fixtures unless it can be so arranged that it will be to their advantage to do so.

London.—The following news item puts a new light on what is considered *waste*:—

“Although the consumption of water in London, England, is less than thirty gallons per head, the East London Water company characterizes this as a waste both *reckless* and *criminal*. It would be rather interesting to know how this company would find language to express itself should it have to deal with a per capita consumption running into the hundreds of gallons a day, as it would have in some of our cities.”

City to Sell Water at Cost.—I hold that no city has a right to sell water to any person or corporation for less than it costs. That cost must take into consideration the interest on the investment, cost of operation, and the depreciation; and the cost of water so obtained to be charged alike to each consumer of water.

Free Water.—The city, as well as the private consumer, should pay for all the water it uses. There can be no such thing as *free* water when it is delivered from the water-works. Some one must pay the cost of delivering every gallon. This being the case, why should the water takers, who at best constitute but a portion of the population of any city, be asked to furnish and pay for all the water used in the parks, schools, and hospitals? or for the water that is used in public watering troughs, and fountains, for sewer flushing, for fires, and for the numerous other uses for which it is expected that the city shall have free water? It might not be objectionable, if these persons who “paid the freight” should have the exclusive right to use all these privileges connected with free water; but they do not, so the matter is clearly unjust.

A city fire hydrant is located directly in front of a man's premises; his insurance rate is affected by that circumstance, and is made lower. He may buy his water of a private company, and not contribute one cent toward paying for the direct benefit of the fire protection.

A city water plant is supposed to be operated in the joint interests of all the people; but as a general thing, if enough

rates are collected from water takers to pay the expenses of the plant, including interest and depreciation, then the property owner who does not use city water escapes any payment for fire service or any other public use of water in which all are interested.

Justice.— There should be no sentiment in the business of selling water ; it is a business matter, and should be handled in a business way. Justice demands that all wastes should be stopped, and the small consumer be relieved of the burden for the waste of the larger water user. All should be charged the cost price of water and no more.

From the experience of the cities of this country that have tried the various systems of rigid inspection of all fixtures when placed in position, as well as frequent inspection of buildings and plumbing thereafter, we can form some plans as to the best way of stopping the larger part of the waste in the water-works plants. But there can be but little progress toward economy in the way of saving water, fuel, and repairs, unless those in charge of the plant are thoroughly posted as to its conditions and needs, and with a superintendent capable and willing to enforce rules, and possessing nerve enough to insist that all be treated alike. There is no place for favoritism in a city plant, and if one consumer is allowed to waste water, or have it at a better rate, it must be at the expense of other water takers or the tax-payer. Justice wrongs none.

Reducing Pressure.— It has been a custom among many plants at the periods of greatest use in the day, as, for instance, the hours allowed for sprinkling in the morning and evening, to reduce the pressure to save water. This method is most unsatisfactory to the consumer, and only serves to engender bad feelings between the head of the water department and the water taker.

Inspection.— Then we have these remedies to correct wastes. A rigid inspection of all plumbing work and material when it is placed in position ; frequent inspection thereafter,— a sort of spy system,— and making a charge for every fixture that is placed in use ; limiting the time of sprinkling to certain hours, and prohibiting the use of garden hose unless the same is held

in the hand ; charging the consumer the estimated cost price of water for whatever purpose used, whether for sprinkling, manufacturing, or domestic use ; the city at large to pay for all the public uses at the same estimated price as is charged to the individual consumer ; and requiring self-closing faucets on all fixtures.

Meters.—The other remedy is the placing of a meter on every service, and then assuming no control or supervision over the plumbing beyond the meter, or of the time or manner in which the meter is used. In this way you leave it optional with the consumer to repair his plumbing or to let it leak, as best suits his fancy ; he will be his own inspector, and will soon get rid of his leaky and wasteful closets and fixtures, or if he so chooses, pay for the water he wastes.

Minimum Meter Rates.—In connection with the meter system comes the often-raised objection that the poor and penurious people would use too little water for sanitary purposes. I think that this objection is largely one of imagination, as when water is sold at a rate of four barrels for one cent, and in some places for less than half this rate, it is hardly possible that any one will suffer for a necessary supply. However, for the convenience of having this water-supply, the consumer should pay a fixed minimum rate. This, of itself, would insure the use of a sufficient amount of water to obviate this objection, and insure the use of water for the flushing of drains, sewers, and prevent unsanitary conditions.

Tenants.—Many water takers are tenants living in rented buildings, and care but little whether water fixtures leak or not, so long as the leaks do not become troublesome. They often move, and it is cheaper to let the leaky fixtures go unrepaired than to pay plumbers' bills. Pipes may be so exposed that a constant flow is needed to prevent freezing in cold weather. If a meter be placed on these premises, and the property owner held for the water rate, the plumbing will be speedily repaired, and pipes protected from frost, and the tenant cautioned to be as careful as possible in the use of water. The result will be that this source of waste will be obviated.

Gas Companies.—Gas companies have found it necessary to use meters in selling their product, but they put no restrictions as to the use that the consumer shall make of the gas. They leave the consumer to the devices and desires of his heart as to how and where he shall run his pipes, and they pay no attention to the number of lights that he uses, or how long a time they are used. Leaky pipes beyond the meter do not concern them; they simply put a silent inspector on each service, and that inspector is a meter. The meter becomes a partner with the gas taker, and keeps him informed of the amount of gas he is using from day to day, inform him of leaks and wastage, and forces repairs and economy by that most touching of ways,—touching the pocketbook.

Leaks in Mains.—Leaks in the mains can be detected by the use of the Deacon Meter, or by the use of a small meter on the surface. Shutting off all services in a given district, in which the valves in the mains are closed, and carrying water from a hydrant outside the district to one inside of it through a hose and meter, is comparatively inexpensive in preparation, and can be tried in almost any location.

Atlantic City, N. J.—In the annual report of Superintendent Hawley, of the Atlantic City, N. J. water-works, there occurs this statement:—

“In my last report I recommended the construction of a new force main and the addition of a new pumping plant at the Absecon station. As has already been shown, the use of meters has effected such a saving, far in excess of what was anticipated, as to render these extensions to the plant unnecessary for some time to come.”

Meters.—Meters have now reached a perfected stage; they are accurate and inexpensive to maintain. A man can read ten meters well scattered while he is inspecting the plumbing of one house. They save time and avoid disputes between the consumer and the person in charge of the water-works. In fact the advantages that have actually been derived from the use of meters have been found to be, diminished consumption on a per capita basis, increased pressure for all purposes, and no more watching for consumers who violate the rules.

In Detroit the use of a few meters, comparatively speaking, has delayed new construction for ten years, while the population has doubled.

The consumer can have all the fixtures that suits his convenience, he can use all the water he cares to, and when and how he pleases. He can sprinkle his lawn all night, if that is his desire, and his neighbor can not make a fuss with him on that account, because he pays for what he uses. The economical consumer does not have to pay for the waste of any one. There are no rules to obey or violate, except such as each consumer shall dictate in his own household. No private business could stand the rates of loss that are going on in all our municipal water-works plants to-day, and it is only because the property owner and tax-payers can be assessed that the works can be operated as they are.

The proportion of water used is about one third of the amount pumped, and the two thirds wasted will cost in fuel, repairs, and extra cost of machinery, and the expense of increased water-supply, enough in ten years to duplicate the plant.

Proper care by a competent superintendent, and the use of meters on all services, will stop most of this waste, and it can not be profitably stopped in any other manner.

In most of the smaller plants, with from five hundred to one thousand services, no additional expense will be incurred by the use of meters, for their care and reading; for the superintendent and same employees can care for them as are necessary to properly care for the plant without them; and it would seem that no city can afford to invest \$25,000 to \$150,000 in a water-works plant, and trust the investment to men untrained in that business to operate.

It will keep any man busy caring for the water-supply, and getting the best to be had in quality and quantity, and keeping it from contamination, stopping waste in all places, not only at the faucet, but in the boiler room.

Politics should have nothing to do with his appointment, or his being retained in the position, and his compensation should be sufficient to induce good competent men to seek such a position.

The Only Way.— The only practicable way to stop the wastes in the water-works systems of this country that I have enumerated, is by the use of the meter, placed on every service, doing justice to all, making all plants self-supporting, but charging no consumer for the wastes of others; reducing one of the principal necessities of life to the lowest price to the consumer, and doing business on business principles.

MR. BRIGDEN: Mr. Holmes advocates no inspection of plumbing inside the curb lines. I certainly could not agree with him in that. We had about five hundred meters in Battle Creek when we commenced our present system, and one cold winter we froze about thirty, causing considerable dissatisfaction, and not a little expense for repairs. Perhaps four or five hundred cases of frozen pipes occurred in that same winter. At the present time, out of fifteen hundred and over meters, we have perhaps four or five frozen during the winter. We have succeeded in cutting down the number of frozen pipes inside of buildings, so that the plumbers are beginning to complain that there is no work for them in the winter time. We hope to be able to cut off what still remain; and, in fact, the freezing that now takes place with us is largely among those services and meters that were put in before we commenced our present system of inspecting pipes by requiring them to be put underneath the floor, in the cellar a foot and a half deep, and a meter to the same.

“ From a financial point of view, Battle Creek can be said to have done as well as any city in the State, and we attribute this largely to the restriction of waste. The operating expenses were paid from the starting of the works in 1897; and in the second year, and up to the tenth, the works earned enough to pay the interest on the \$100,000 bonded debt at four per cent. We now look forward to paying off the entire bonded indebtedness, as it becomes due in annual payments of \$10,000, if the money is not paid for very extraordinary construction work. Since 1897, cut-off meters and other construction work, also all interest and operating expenses, have been made from earnings, and a \$10,000 surplus stored up. The rental of meters now pays for all meters purchased, except those sold to persons preferring to buy rather than rent.

Other cities have commenced to meter their consumers, and to restrict waste ; notably, Kalamazoo and Lansing, and Jackson to some extent. The result of that has been a large decrease of their consumption. I think, from what they tell me, that they have difficulties to meet which we do not. The habit of waste grows with people. We have cut down our per capita consumption, to about thirty to forty gallons, and we know that some of the cities around us are using three or four times that amount, and some cities, possibly Buffalo, N. Y., and Washington, D. C., over two hundred gallons per day per capita. Such waste as that would tax our plant so that we could n't run it. It strikes me that water-works ought to be run just as a business house would be run, and ought to be run with an idea of economy. We tried inspection for the reduction of waste, and found that we made something of a success of that. All sorts of things are done to get rid of paying water bills, and I don't think anybody can arrive at a correct conclusion as to what should be done to properly proportion the bill to be presented to a large concern having thirty, forty, or fifty openings for water to flow from.

MR. TEED: The question with me is whether we get the correct amount of water, if we have the meter. We certainly do not get it in Cadillac, because in the last three years we used just about the same amount of water as the first, and yet this last year they charged us as much as they did for the three previous years put together.

MR. BRIGDEN: That would be possible, but not very probable, I think. You can test the meter, and they are as capable of regulation as a steam-engine.

MR. C. W. HUBBELL: The consumption in large cities is generally conceded to be larger in proportion than in smaller ones. This is especially true in American cities, of which Detroit is a fair example. We reached our high-water mark in about 1888, in which year we pumped an average of two hundred and four gallons per capita a day. At that time we began the introduction of meters, and our present per capita consumption averages one hundred and thirty gallons a day. This makes a very flattering showing for the meters on the face of the figures presented. However, when entered into in

detail and with care, the showing is perhaps better than should be accorded entirely to the use of meters. This subject was very carefully investigated by Mr. Williams about a year ago. The results of that investigation have never been made public, and I do not feel at liberty to enter into the detail of the investigation. However, I may mention a few of the circumstances that we found to exist in 1888. In the first place, every engine in our pumping station at that time had a waste-pipe six inches in diameter, which it was customary to leave running during the night in order not to necessitate the stopping of the engine. By experiment, we found that at least six million gallons per day had been wasted in that way. By a device since then placed on the engine that waste has been saved, and of course that six million gallons is credited to the introduction of meters. The actual sum saved in the operation of the engine, etc., has saved us about two million gallons a day. We have found that the metering of small consumers in private houses does not save the amount of water usually credited to meters, and during the last year we have taken out a large number of our small meters, and are not now placing such meters unless we find evidences of leak. Our present consumption per capita a day is about one hundred and thirty gallons, and a probable waste of eighty gallons per capita leaves a net consumption of perhaps fifty gallons. Where this waste is, of course, is very difficult to determine. We have, since the introduction of meters, expended for the meters themselves about \$90,000, and for the operation, maintenance, and repair of meters, something like \$85,000 more. The annual cost of maintaining, reading, and repairing meters varies from \$7,000 to \$10,000 a year, which is a very large item of expense, and represents a good deal of capital. Therefore, I would say that the results that appear in our annual reports from year to year should be taken with caution by those who contemplate the introduction of meters, because they do not show the existing facts in the case. We have tested several sections, and find that where there is waste, it is nothing like what we would expect from our night pumping from the hours of one to three o'clock, especially Saturday and Sunday nights,

when all respectable people are supposed to be in bed, and when all the factories are supposed to be closed, we still have a consumption of about one million gallons per hour. This must be due to leaks, and many cases of large leaks can be found only by inspection. I think this is all I have to say without special preparation on the subject. I don't wish to be understood or to intimate that meters are not a good thing when properly used; but we found that if we carried on our present rate of placing meters we would soon have run in a great deal more money than we saved. We don't save enough money to pay for the expense of the meters.

MR. WALKER: In regard to this waste, I want you to tell me how to correct it. Some years ago I happened to be connected with the commission in Port Huron, and every month we got out a report showing how much water we had pumped, how many consumers there were, and one thing and another. Somebody pitched into me one day with the assertion that we were not pumping any such amount of water; if we were, it was a waste, and he would like to know where it went. I said, "Sherman, it is a waste, of course." "Well," said he, "who is wasting it? It ought to be stopped; it is all a nuisance." I said, "Yes, I guess that is so; but we waste it up at our house, and you waste it at your house." "Well," he said, "I don't believe we use a barrel of water a day." I said, "Now I wish you would work it some way to find out how many gallons of water you draw out of those bibs." He said he would find out. When he went home to dinner he took a couple heads of lettuce. He told me this afterward. He said he heard the water running, and it had been running for four or five minutes, and he looked around, and the girl was washing the head of lettuce. The bib was wide open, and she would take off one leaf and wash it that side and this side, and then take off another. He figured up the water, and found it actually took four and a half barrels of water to wash a head of lettuce, and he concluded he was using his share of water. Now these are the things that do this.

MR. BRIGDEN: A part of our town is one hundred feet above the pump, and we have to pump pretty hard to get a pressure. A fellow has a little garden out there, and he pays

five dollars a year for all purposes,—sprinkling his garden, lawn, etc.,—and one day he came in and said, “I wish you folks would carry about ten pounds more pressure.” “Well,” I said, “can’t you get any water up at your place?” “Yes, I can get water all the time; but I have only fifty feet of hose, and I can’t reach all over my garden with it, and I think you ought to use fifty pounds pressure so to save me buying fifty feet more of hose.”

MR. WALKER: One question is asked me very often, and that is, “Why is the great difference in the rates between the large consumer and the small?” I don’t know as the water that goes through a small meter costs the consumer any more than it does where one has used a very large amount.

It has been figured on by quite a number of cities, especially Rochester, N. Y., Madison, Wis., Richmond, Va., and Atlanta, Ga. There is a certain amount of service that goes to every tap that is uniform without regard to the amount of water. There is the care of the meter. With our fifteen hundred meters the entire cost for the care of them was about \$200 last year. But the charges of bookkeeping, caring for the meter, reading the meter,—all those things are uniform in every case; that is, a small meter takes just as much care as any meter, no matter how large. Against my advice our board reduced the minimum water rate to three dollars a year; that did n’t include the furnishing of the meters, for we rent meters for fifteen per cent. on the actual cost, or sell them to the consumers at the actual cost. There is a great difference of opinion as to water rates, but still every one acknowledges that there should be some minimum rate which will cover these expenses.

MR. HOLMES: Milwaukee has made a very exhaustive examination of that question. For three years there has been a great deal of feeling there in regard to the water rates, which have been on the sliding scale, and they have finally adopted this plan: They charge six cents per thousand gallons for all water supplied to the consumer, great or small; they charge one dollar for the reading of the meter: it is not really a minimum charge of a dollar for reading, but it is a dollar for reading one meter, and six cents per thousand gallons for all the

water supplied. Milwaukee, of course, has got an inexhaustible supply of water, and is a largely metered town,— as closely metered as any town we have, is it not, Mr. Brigden?

MR. BRIGDEN: I presume it is, with the exception of Fall River and Providence.

MR. HOLMES: Every man that wants a meter can have it, and he must pay for it, and must pay a dollar a year for the care of that meter, and must pay six cents per thousand gallons for the water actually used, and no more. Now that is the way they have settled it, and it seems to me that is fair. I believe that water should be furnished to the consumer at cost price, and I think Milwaukee has got as near to it as is practical for them to get. Now if they give a person sixteen thousand gallons of water a year for a dollar, and then the charge of one dollar for reading the meter, that person actually pays out only twelve cents a thousand gallons for water. Grand Rapids put on a meter last fall in John Ball Park for the purpose of ascertaining how much water was used. It was n't put on until the first of October, after the summer season was over, and was only supplying the birds and beasts and fish and such things as that in the park, and still that was turned around at the rate of eight dollars a day on a five-cent a thousand-gallon basis; and that shows where the water goes, you see.

THE PRESIDENT: It seems to me that there are certain fixed charges in connection with the water-works, and when you add those together it makes a comparatively smaller rate for the small consumer than the larger one; I think it is equitable.

MR. WALKER: Many cities are furnishing water to large consumers at a great deal less per gallon than a small town can pump it for, and they jump from five or six cents per thousand gallons up to twenty-five and thirty. It is all out of proportion. But there is no occasion for charging one man five or six times as much for the water he uses as another man is charged for what he uses.

MR. BRIGDEN: I think you will find that very few cities make the difference such as you specify; I think it is less than double. The charge for the large consumer is more than half what it is for the very smallest consumer.

COAL AND COAL-MINING IN MICHIGAN.

CHARLES HOLMES, SAGINAW.

As a member of your committee on Forestry I have to report myself delinquent, but in extenuation of my shortcomings I beg to offer for your consideration some facts concerning the "fossil relics of primeval forests."

During the past year a strong desire seems to have got abroad to verify the belief that Michigan contains many square miles of workable bituminous coal-fields, and thereby determine their particular location. The city of Saginaw, being near the center of the coal group, and having developed some good coal, became the Mecca to which many "coal men" from Ohio and other States made pilgrimage. The situation seems to be that the Ohio mine owners realized that the mining of a good coal in this State would bring the operators in direct competition with those of Ohio in the markets of the Northwest, and, attracted by this promising field for coal-mining operations, several Ohio as well as local coal companies, made great haste in the early part of the year to leave several thousand acres of land in Saginaw, Genesee, Shiawassee, Tuscola, Bay, and Huron counties. Exploring quickly followed the leasing which accounts for the large number of drilling-machines which have been in active work through the past year. The results of drilling are carefully guarded by the operators, hence the general public learn very little of the thickness and character of the coal seams before a shaft is sunk and active mining operations commence. Speculation, therefore, has been and still is rife as to whether the coal deposits will yield us rich legacies, or the workable quantities are small in area and of brief duration. It is a well-established fact that the coal, to the extent of the depth explored, lies in detached strata; but it is too early yet to form any idea of the area, in any district, capable of producing coal in commercial quantities. The newspapers duly exploited this important coal discovery, and printed columns of exclusive news about it, but the narrative

was very like the old-time novel — *founded on facts*, the main difficulty being to determine where the facts ended and fiction began.

Coal-fields of Michigan.— The exact center of the coal-fields of this State, as far as it can be determined by our present knowledge of the subject, is on the Michigan meridian six miles north of the southwest corner of Saginaw County. The area within the belt occupies the entire counties of Clare, Gladwin, Isabella, Midland, Bay, Gratiot, Saginaw, Shiawassee, Clinton, and Ingham; a considerable part of Arenac, Mecosta, Montcalm, Ionia, Eaton, Jackson, Livingston, Genesee, and Tuscola, and smaller areas in Huron, Osceola, Kent, Calhoun, and Washtenaw; covering in all, as I estimate it, 9,810 square miles. This area is nearly double that given by the encyclopedists and the earlier geologists; it is but a trifle in excess of that indicated by the latest map compiled by our deputy State geologist, and is based on the latest investigations made by that official.

Outcrops.— Few outcrops of coal occur in the State. In the northern and central part of the group I remember to have seen but two; one is on the Flint River near Flushing in Genesee County, the other on the Rifle River near the northwest corner of section 2, T. 19 N., R. 4 E., but I have reason to believe that it crops out in many places in the bed of both rivers. The coal-mining started many years ago at Williamston, was, I understand, in crop coal. At Grand Ledge crop coal is being mined on a small scale. At Flushing where the outcrop occurs, coal is extracted through a drift opening made into the coal seam, and fire-clay is excavated from the river bluff. Both materials are shipped to Saginaw by the Saginaw Clay Company; the clay is used in the manufacture of paving brick, and the coal is used for generating steam and burning kilns. In the light of present knowledge this has proved to be "carrying coal to Newcastle," as both materials underlie Saginaw and its suburbs.

Northern Coal-fields.— Near the outcrop on the Rifle River a shaft was sunk some years ago to the coal, and an entry driven. It was worked for a short time, and then abandoned.

Twenty-three years ago I made my first camp-fire of coal which I found among the detritus on the banks of the Rifle River; I was then on a trip of exploration and set drillers to work near the northern limit of the coal belt. The test holes were worked down to a depth of one hundred and sixty feet, but no coal of any account was found. Four or five holes were also sunk to the same depth, at about this time, farther south, but with like results. Subsequently considerable drilling was done at various places in the northern part of the belt, and some veins of coal were found of workable thickness. The pieces which I found on the banks of the Rifle indicated a good quality of coal. It burns with a bright blaze like hard wood, and under combustion gives out but a slight odor of sulphur, and leaves a grayish colored ash streaked with dull red. It resembled cannel-coal, dull and textureless, but that condition was, perhaps, due to attrition. At present the coal land comprising the northern part of the belt is undeveloped.

The Sebewaing District.—In the northeast part of the belt an area of about four square miles has been explored with good results. The district is known as the Sebewaing coal-fields, in which drilling and mining disclosed veins of coal from $3\frac{1}{4}$ to $5\frac{1}{4}$ feet in thickness. The surface of this district is level, and the average depth of eight test holes to and including the coal, is 87 feet, the average depth of the coal being 4 feet. A characteristic drilling runs about as follows: Clay 45 feet, sand and gravel 2 feet, sand rock 25 feet, shale 10 feet, coal 4 feet. Two tests found a thickness of 42 feet of sandstone.

Two mines have been opened up in this district. The Saginaw Bay Coal Company sunk its shaft on the N. W. $\frac{1}{4}$ of S. E. $\frac{1}{4}$ of Section 18, T. 15 N., R. 9 E., near the Saginaw, Tuscola, and Huron Railroad some eight years ago, and equipped it with appliances of the best and most modern kind. Operations were suspended three or four years ago and have not been resumed. This company mined out a small section—about sixty acres.

The Sebewaing Coal Company was the first to sink its shaft and market coal at Sebewaing. Its mine was opened up in 1890 and is still in active operation. The first shaft sunk, but

now closed, is on E. $\frac{1}{2}$ of S. W. $\frac{1}{4}$ of Section 8. The second shaft, now in use, is on the W. $\frac{1}{2}$ of Section 8, T. 15 N., R. 9 E. It is a shaft mine, as before stated, worked by the double entry and pillar-and-room system, the ventilating current being created by exhaust steam of the mine pumps, an escapement shaft being used as the downcast. The roof is remarkably stable and the mine is fairly dry. The quality of the coal in the mine and in the same seam, as there is only one seam worked, is variable. The seam generally has a regular and gradual dip toward the sump, and only in one lateral entry has a rise in the coal seam been found which prevented the safe handling of pit cars, even when heavily spragged. The coal is blasted from the solid face and brought to the bottom in cars, by mules. Pyritic iron is distributed throughout the coal, reaching in quantity as high as twenty-five per cent. of the coal seam and masses of it, called *boulders* by the miners, in cubical-shaped crystals, is found in the draw slate. But while the amount of sulphur in the form of iron pyrites is undesirably high in this coal which lessens its value partly by the formation of sulphide of iron and tenacious clinkers which have a tendency to destroy grate bars, still, in furnaces where proper appliances have been used to overcome this objectionable feature, the coal has proved of high value for heating purposes. The S. T. and H. R. R. Co. has for a long time used it for generating steam and heating station buildings.

The Michigan Standard Mining Company was formed recently to mine coal in this district and commenced sinking a shaft last month.

Bay County Mines.—Southwesterly from Sebewaing and nearer the center of the coal measures are two mines known as the Monitor Mines, located five miles west of Bay City, in Sections 28 and 33, T. 14 N., R. 4 E. Late in the fall of 1895 the Monitor Coal Company sunk a shaft and began mining coal. Excepting the suspension of mining due to strikes, the mine has been in operation ever since. This company was the first to market coal from a Bay County mine. About one year later the Bay Coal Mining Company sunk a shaft near that of the Monitor Company, and continued mining

coal until a few months ago when the North American Chemical Company acquired the property; the inference is that the product of this mine is now being used in the manufacture of chemicals.

The North American Chemical Company recently located at Bay City is a scion of the United Alkali Company of England capitalized for over forty million dollars. This vigorous offspring is capitalized for over half a million dollars, is doing business under the laws of this State, and will mine coal as well as manufacture chemicals. It has already secured leases on several thousand acres of land in Bay and Saginaw Counties.

So far as I am aware, no other coal in this district has been marketed than that taken from the Monitor Mines. Ground was broken in the recent past for four or five shafts in the vicinity of Bay City, which is a gratifying indication that coal veins have been found of workable thickness. Late reports however, from this district show that the labor on two shafts has been lost. One loss is by reason of the coal vein, at the shaft, proving too thin to mine and the other, as far as the shaft was sunk, was due to the pumping out of water and sand which wrecked the timbering to a degree that was beyond recovery. Thus, our Bay County friends seem to be getting knowledge of the necessity of frequent drillings and the difficulties attending shaft sinking, through the hard lines of experience. Much exploring has been done in the past year in this county as well as all the territory lying south of it to the limit of the coal measures.

Saginaw Coal-Fields.—The existence of coal in the Saginaw Valley has been known for many years, and, notwithstanding the fact that in the past twenty-five years much money has been invested by prospectors in testing at various places, it is only within the last four or five years that coal has been found, in any areas, of character to insure profitable mining. Capitalists seem to have been slow to undertake the work of mining the coal, but it is now sufficiently developed to assure a liberal return for the investment of capital, and it gives promise to become, in the near future, an important industry. The money

used for exploration in this valley, prior to this year, was mostly advanced by citizens of Saginaw. The drillings were made several miles from the city with the usual attendant of successes and failures, and, strange to say, inside the city, coal was accidentally found in 1895 which led to the discovery of an extensive basin in the city and suburbs where it had not been looked for. The first coal-mining done at Saginaw was in the fall of 1896 when the Saginaw Coal Company sunk its shaft near the south and east boundaries of the city. Fortunately, for the success of the enterprise, the actual work of mining was first done under the management of a gentleman of extensive experience in coal-mining, and it was soon demonstrated, after the shaft was sunk, that we had a fuel equal to any produced at the Hocking Valley, and fuel users were not slow to discover it.

The Saginaw Coal Co.'s mine is located on a plateau, the divide between the Saginaw and Cass rivers. In sinking the shaft the following strata were passed through: clay 54 ft., sand and gravel 3 ft., soft clay 37 ft., sand 4 ft., hard-pan 5 ft., shale 1 ft., coal 1 inch, gray shale 18 ft., black shale $6\frac{1}{2}$ ft., coal 4 inches, hard, sandy fire-clay 1 ft., gray shale 5 ft., black shale 12 ft. 2 in., and coal 3 ft. 3 in. A drilling below the last coal found fire-clay 18 ft. thick, sand rock 34 ft., and sand shale 3 ft., in the order named. The coal has proved to be somewhat irregular in formation, and the system of working has to be raised to suit the raise and dip of the coal. The roof is tender and disintegrates rapidly on exposure to the air, and much care is taken and expense incurred to avoid accidents. The vast amount of clay and shale raised to and lying near the pit's mouth, testifies to the large amount of dead work which has been done to bring the water from the so-called swales, or dips, to the sump. But it remains there the same inert mass that it was in the mine; unlike that at the Sebewaing mines where the gob piles during active mining are like a volcano burning and converting the mass into scoria; and like "hell itself breathes out contagion to the world." The system of working is that of the double entry. As the workings get more remote from the bottom, the entries are drifted wide, which leaves a goaf for gobbing back,

the extra timbering costing less than removing the waste to the surface. The mining, on the whole, has been systematic and practical. Each pair of main entries or gangways are drifted to the cardinal points of the compass, but one thing and another has necessitated the drifting of butt, cut-off, and all other entries and airways in every conceivable direction. When more favorable conditions in the coal seam and roof are found, rooms will be worked out on parallel lines, and less coal wasted. But whether or not pillars will be drawn in the mines working out the "Saginaw Seam" will be decided later. It is intended to adopt the long-wall system of mining whenever the opportunity to do so occurs; but regarding mining in the future, it can only be said at present that developments so far have justified us in indulging "great expectations." Drifting back to the Saginaw mine, I would say that the first year the mine was opened it was ventilated by natural pressure, but subsequently by a fan placed on the surface near the shaft. When in the mine, I have generally found the volume of ventilation ample for the needs of the occupants, and so far the sanitary condition is good. It was deemed necessary for the safe working of the mine and to maintain a good sanitary condition in it, to sink an escapement and air-shaft. One was started a short time since, and completed last month, and to sustain good ventilation, a fan 14 feet in diameter will be soon added to the equipment. A good volume of air will then be maintained and carried to the remotest working faces for some time to come. All parts of the mine in active working are kept clear of litter and brattices, and doors are well and tightly constructed. The plan of the workings of the mine show that break-throughs between working places are rarely made more than 60 feet apart, they are more often 50 feet and less. The lawful distance in Ohio is 60 feet. Some of the dangers incidental to mining have been experienced. A squeeze occurred in one part of the mine which was overcome by persistent and energetic work, and in the early part of the year water broke through in quantity to necessitate the installation of a large mine pump. The mine is operated in day-time only, all entries are used as haulways, therefore surveys

of the mine have to be made at night. The hour of shooting is 4 p. m., at which time all work is suspended in the mine, and the men hoisted to the surface. At 8 p. m. the powder smoke generated during the blasting is sufficiently diluted to allow re-entrance to all parts of the mine. The maximum daily capacity is 600 tons.

The hoisting outfit is of modern design as is also the tippie, or "head-gear." The hoisting machinery consists of one pair of vertical engines with 12"x12" cylinders and link motion, connected to a drum shaft by a pair of spur gears reducing the motion in the ratio three to one: this drum shaft carries two drums grooved for a one-inch cable, which are 48" diameter. The cables are attached in the usual way, that when one cage is hoisted the other cage is lowered. The motive power is steam which is furnished by three boilers: one Upright Wickes's Patent Water Tube boiler of 250 H. P., one horizontal tubular boiler 60"x15' of 75 H. P., and one horizontal tubular boiler 54"x14' of 60 H. P. Owing to the mine water developing mineral salts destructive to boilers and steam fittings, it became necessary during the fall to lay about seven thousand feet of four-inch water pipe from the city mains to supply the boilers of this and the Père Marquette Mine.

The Père Marquette Coal Company opened its first mine on Section 32, T, 12 N., R. 5 E, three-quarters of a mile southeast from that of the Saginaw Coal Company. In the early part of July, ground was broken for a shaft opening and by the middle of August the bottom of the "Saginaw Seam" was reached. As soon as the shaft was sunk, active work was carried on in the mine and on top to perfect the equipment necessary to mine the coal. The entire equipment which has been completed for some four or five weeks is of modern design and entirely up-to-date. This company enjoys the distinction of having the best equipped coal mine in the State.

As the hoisting machinery differs somewhat from that of the Saginaw mine, a few remarks about it may be of interest. It consists of one pair of 16"x24" horizontal engines with link motion, connected direct to drum shaft; this shaft carries two differential hoisting drums grooved for a one-inch cable. Two

cables are attached to drums in the usual way to balance cages. The differential drums are 46" diameter at the ends and 60" diameter in center. The motive power is furnished by one Upright (Wickes's Patent) water tube boiler of 200 H. P. The machinery for this and the Saginaw mine was designed and manufactured by the well-known firm of Wickes Bros., Saginaw, and all the boilers are from their shops.

The preliminary work of drilling for location for a new shaft, to be sunk by the P. M. Co., is well under way. The probable location of the new mine will be inside the city of Saginaw, on the west side of Saginaw River, where the condition of the roof overlying the coal has proved to be better than it is in the east side mines.

Another mine is in active operation near the south boundary of Saginaw. It is located in Section 6, T. 11 N., R. 5 E., and was added to the roll of mines in this district last summer. It is operated by the Standard Mining Company, and is under the management of one of the most experienced miners in the district, he having been engaged in the mining business in the Jackson district for many years. As a consequence the mine equipment is of the right kind, and the subterranean work is skilfully conducted. The mine has a capacity of about 500 tons a day.

One abortive attempt has been made in this district to sink a shaft, and, presumably, win coal from the "Saginaw Seam." The undertaking showed on the part of its manipulators, a very inadequate conception of the mechanical and scientific side of mining; but the failure is now a thing of the past, and can be reviewed with propriety.

A glance at the method adopted to sink the shaft, and the manner in which the alleged mining was to be done, if, indeed, anything should have been found valuable enough to mine, showed that at all stages of the work the purpose was to renounce all relations with those two venerable personages, water and air. But —

"The best-laid plans o' mice and men
Gang aft a-gley."

During the progress of the work, last spring, the Saginaw river overflowing its banks covered the ground at the pit's mouth to a depth of six to seven feet, and filled the shaft. The water was pumped out, and work on the shaft resumed. But after about eighteen months of unproductive toil the shaft was abandoned because there was not room enough in it to pump out the ever-increasing inflow of water, and excavate at the same time. It was to have been *a dry shaft and mine*,—an undertaking which would have given special emphasis to the expletive of Dominie Sampson.

The plan, it was said, was designed to revolutionize the prevailing method of mining coal, and for a time, during its execution, excited the mining fraternity. It consists of two circular shafts, each five feet two inches in the clear, placed about 10 feet apart, through which coal is to be hoisted with an endless chain and buckets. The upper section of the abandoned shaft down to the rock was cased with cast-iron pipe in sections of 12 feet, weighing 6 tons each, and fitted together with the ordinary hub and spigot joints. At the lower end of the pipe a shoe was fitted which rested on the solid rock in a manner which was to have excluded water from the shaft. The rock on which the shoe rests is 97 feet from the surface, and the depth at which the work stopped is 120 feet. The casing is 10 feet out of plumb, and some of the joints are fractured. With all other adjuncts for coal-mining the shaft could be used for an air-shaft, but it cost money enough to sink more than a dozen air-shafts by the prevailing method. It appears to be a crude imitation of the Kind-Chandron system of shaft-boring.¹ The plan and its execution, as far as it went, is credited to a lawyer who was formerly a house painter. The undertaking taught nothing, but it may have emphasized the instructive fact to those who were unfortunate enough to put their money in the *hole*, that shaft sinking and coal-mining is

¹ See a paper read before the American Institute of Mining Engineers, at Philadelphia meeting, June, 1876, by Julian Derby, C. E. For drawings of the apparatus used, see Vol. 2, page 430, of Appleton's Cyclopædia of Applied Mechanics.

as much a trade as the making of paint or the making of briefs, only it is less comfortable and more dangerous.

The J. H. Somers Coal Company operating at the village of St. Charles, in this county, has had extensive experience in coal mining in other States. The company's agents were early in the field, and without any flourish of trumpets, proceeded quietly to their work, and secured by purchase and lease what has proved to be some valuable coal properties. The first coal raised by this company for market was last spring, this was the first coal won from the "Saginaw Seam" in this part of the county. The equipment of the mine is all modern and of the best. It is the only mine in the State in which machine cutting is done. At present six machines are in use, and the motive power is electricity of low voltage. The power of electricity to mine and haul coal is used by this company in Ohio; its success in coal mining operations is now pretty well established. The mine shaft is 182 feet deep, and passes down through the following strata, the thickness of which is expressed in feet and fractions of a foot, viz.: clay 28, sand and clay 3, hard-pan 9, quicksand $2\frac{1}{2}$, black shale 25, gray shale $16\frac{1}{2}$, sand rock 19, shale $\frac{1}{2}$, coal 2, fire-clay 6, gray shale 8, black shale 4, fire-clay $4\frac{1}{2}$, gray shale 23, black shale $2\frac{1}{2}$, fire-clay $\frac{1}{2}$, black shale $25\frac{1}{2}$, coal $3\frac{1}{2}$. The three-entry system is used with fan ventilation. The roof is composed of hard black shale, and is good. The capacity of the mine per day of two eight-hour shifts is 1,200 tons. The coal is somewhat harder than that taken from other parts of the seam, and is of remarkably good quality. This company has commenced sinking another shaft.

Among the many companies which created some excitement at Saginaw last winter in leasing lands for prospecting for coal was the Wills Creek, of Ohio. This company is reputed to have an abundance of capital at command. It placed a small army of men, "of all sorts and conditions," in the field to solicit leases from land owners and they no doubt leased many thousand acres. The real object of the company in leasing so large an acreage was, and is yet, a matter of conjecture. Its professed object was to mine the "Saginaw Seam" on a

very large scale. This Company organized to mine coal in this State under the name of the Northern Coal and Transportation Company. One shaft has been sunk by the company at the village of St. Charles, and preparation is being actively made to market coal. The company has also been sinking on Section 7, T. 11 N., R. 4 E., for some time past, but of late progress there has been slow on account of having encountered a large body of water and sand. The work is in the hands of expert shaft sinkers, and it is confidently expected they will work through it without losing their labor. A spur railroad track from the Flint and Péré Marquette system to the shaft is in course of construction.

The first coal was mined and marketed in Saginaw County some four or five years ago. It was taken from what is known as the Albee mines, situated on the N. W. $\frac{1}{4}$ of Section 23, T. 10 N., R. 4 E. The shaft was sunk $2\frac{3}{4}$ miles west of the Cincinnati, Saginaw, and Mackinaw Railroad, and most of the coal was hauled to the railroad by teams, and loaded on the cars by hand. After experiencing many vicissitudes of fortune, the first operators ceased mining coal. Just one year ago some Saginaw gentlemen purchased the property, and after organizing a company and changing the name to the Verne Mine, proceeded to pump out the old workings, sink a new shaft, construct a spur track from the main line of railroad to the mine, and put the plant generally on a good working basis. It is now one of the recognized industries of this county, and is managed by R. W. Roberts, C. E.

The shaft is 68 feet deep ; in sinking it the following strata were passed through : clay 16 ft., hard-pan 22 ft., sand 2 ft., shale and slate 25 ft., coal $3\frac{1}{4}$ ft. Underlying the coal is fire-clay $6\frac{3}{4}$ ft., and then sand rock. The system of working is the double entry, drifted narrow at present, and pillar-and-room. The ventilating current is created by natural pressure, and is carried through an air and escapement shaft ; preparation is being made to increase the volume of ventilation by adding a fan to the ventilating equipment. The mine has a daily capacity of 400 tons, and produces a hard, blocky coal of excellent quality.

A shaft was sunk some time since in the S. E. $\frac{1}{4}$ of Section 23, and some immethodical mining done. This mine is abandoned.

Corunna Mines.—Bituminous coal has been mined at Corunna, in Shiawassee County, the past thirty years. Recent developments of the coal resources in other parts of the State have been the means of renewing the interest of operators in this promising field. Large areas have been leased during the past year around the old and abandoned mines, and considerable exploring has been done there. Operations have been carried on mostly in T. 7 N., R. 3 E. The Corunna Coal Company has a shaft opening on Section 13, and the Owosso Coal Company sunk one on Section 23. Both mines are now in active operation. The old and abandoned Kirby mine is on Section 24, and other abandoned mines exist in its neighborhood.

Jackson Mines.—Near the southern limits of the coal measures coal was first discovered on Sandstone Creek (in Sec. 1, T. 3 S., R. 2 W.) while digging for the foundation of a mill. At the Woodville mine, in the southwest part of Blackman township (T. 2 S., R. 1 W.) and two miles west of the city of Jackson, coal was first developed in this State by sinking. It has been mined in this district during the past forty years: as to how far it is mined out it is impossible to state. The coal lies in detached small basins which from time to time will be brought to light, and may last for years. The coal is similar to, but possesses less impurities than, that mined at Sebewaing. Parts of the veins are largely impregnated with sulphur, which at one time was converted, with profit, into sulphuric acid. The coal is worked by the pillar-and-room system, but no gunpowder is used: it is undercut, and then detached from the roof by driving wedges between the top of the coal and the roof. The operation is called by miners "Wedging Down."

Quantity and Quality.—It must be admitted that the subject of coal and colliers, being so much in review by magazine-writers, has become somewhat hackneyed. It may be true that, viewed in the light of the world's production, the older

writers on the subject of Michigan's Coal-fields were justified in regarding them as unimportant; but considering the rapid depletion of the forest areas of this State, in relation to the fuel supply, the question of the amount and character of our available fossil fuel is really one of much importance at this time to the people of Michigan.

The "Saginaw Seam," to which attention has been mostly given, varies in thickness from 24 to 54 inches (not taking into account thinner veins passed through), the prevailing thickness being 40 inches. The coal is of excellent quality especially for steam and manufacturing purposes. It is equally good for house use as it gives out little soot, and burns up to a light ash without clinkers. It is entirely free from those substances found in some coal, which are known as impurities. Some cannel-coal has been found, and but very little "black jack" or bone-coal. A rumor that anthracite has been found lacks proof. In the Sebawaing district the workable vein is from 39 to 63 inches and the prevailing thickness is 49 inches. Some trustworthy tests were made eighteen months ago by the Grand Trunk Railroad Co., to ascertain the quality of Saginaw coal in comparison with that mined by the Wills Creek Coal company in other States, and which the railroad company then had in general use. I am indebted to the Saginaw *Evening News* for the following copy of the record, a blue print of which was given the *News* by superintendent William Cotter, of the Grand Trunk road:—

KIND OF COAL USED.	SAGINAW.	WILLS CREEK.
Number of engine.....	143	143
Date.....	June 4 to June 14	June 14 to June 21.
Average steam pressure.....	144 pounds	142.5 pounds.
Total weight of water evaporated.....	699,465.9 pounds	674,323.6 pounds.
Total weight of coal consumed.....	114,050 pounds	110,985 pounds.
Temperature of feed water.	62 degrees F.	65 degrees F.
Equivalent weight of water evaporated at 212 degrees F. and atmospheric pressure	840,058 pounds	809,668 pounds.
Weight of water evaporated per pound of coal.....	6.31 pounds	6.08 pounds.
Equivalent weight of water evaporated at 212 degrees F. and atmospheric pressure per pound of coal.....	7.37 pounds	7.21 pounds.
Average weight of trains hauled.....	642.4 tons	544.5 tons.
Total weight of trains hauled.....	5,133 tons 390 pounds	4,756 tons 183 pounds.
Number of engine miles with train.....	1,241.2	1,241.2.
Number of engine miles light.....	40	40
Total number of engine miles.....	1,281.2	1,281.2 .
Pounds of freight per pound of coal.....	90 pounds	85.7 pounds.
Pounds of coal per engine mile.....	9.2 pounds	8.85 pounds.
Number of hours under steam.....	121 hours, 28 minutes	110 hours, 50 min.
Number of hours on road with train.....	62 hours, 55 min.	56 hours, 45 min.
Number of hours actual running.....	48 hours, 14 min.	41 hours, 25 min.
Weather report.....	1 trip clear, strong tail wind. 2 trips clear, head winds. 4 trips clear, side winds. 1 trip rainy, side wind.	1 trip clear, strong side wind. 2 trips clear, tail wind. 3 trips, rain and cloudy. 2 trips clear, side wind.
Description of coal.....	An easy breaking coal containing very little fine coal or dirt. No sulphur or slate. Most of this coal was in large lumps. Clinkers very little. Grates shaken three times during the test.	A medium breaking coal containing large quantities of fine coal and dirt. No sulphur or slate. Clinkers considerably. Grates requiring frequent shaking.
Total weight of ashes.....	ASH PAN. FRN'T END 7,407 lbs. 1,001 lbs.	ASH PAN. FRN'T END. 9,998 lbs. 920 lbs.
Relative efficiency, assuming Saginaw coal as 100.....	100	97
Remarks.....	On the first trip west the super-heated pipes leaked slightly.	During the past 2 trips the flues and superheated pipes leaked a little.
Kind of trains.....	Beef and merchandise.	Beef and merchandise.

DETAILS.

SAGINAW.

		Weight of Trains. Tons. Lbs.		Water. Lbs.	Coal.	Ashes. Ash Pan. Front End.	
June 4.....	West.....	554	757	88,036.21	16,700	1,026	
June 5.....	East.....	767	1,426	93,196.17	11,250	965	120
June 7.....	East.....	829	34	91,512.17	16,150	937	118
June 8.....	West.....	525	1,691	90,375.44	16,250	892	136
June 9.....	East.....	643	1,479	79,017.01	15,550	798	108
June 10.....	West.....	470	1,385	82,265.76	13,550	895	133
June 11.....	East.....	825	994	90,239.43	11,200	988	240
June 12.....	West.....	516	624	84,823.71	13,400	906	146

WILLS CREEK.

June 14.....	West.....	510	1,199	87,059.35	13,500	1,100	
June 15.....	East.....	659	114	73,035.95	12,200	1,051	186
June 16.....	West ..	571	225	88,734.12	13,000	1,220	205
June 17.....	East	648	1,981	86,701.45	15,450	1,302	163
June 18.....	West.....	483	1,219	84,402.61	13,700	1,145	
June 19.....	East.....	699	1,022	79,574.89	12,100	1,120	160
June 20.....	West.....	493	1,380	85,322.54	16,735	1,526	
June 21	East.....	689	1,043	89,892.71	14,300	1,534	206

My desire, gentlemen, is to give you all the authentic data to date available, concerning Michigan coal. I, therefore, present the following report of stationary boiler trials made at Saginaw, by E. C. Fisher, M. E., to determine the comparative value of Saginaw marketable coals : —

Date of Trial.....	Hours.....	9-14-1896	9-15-1896	9-16-1896	9-17-1896	9-21-1896	9-22-1896	9-23-1896
Duration of Trial.....	10	10	10	10	10	10	10	10
Name of Fireman.....	Wm.	Wm.	Wm.	Wm.	Wm.	Wm.	Wm.	Wm.
Number Times Fire Cleaned.....	Once.	Qualman.	Qualman.	Qualman.	Qualman.	Qualman.	Qualman.	Qualman.
		None.	None.	None.	None.	5	3	7
DIMENSIONS AND PROPORTIONS.								
Kind of Grate.....		Wickes	Wickes	Wickes	Wickes	Flat, with	Flat.	Flat, with
Length of Grate.....	Feet.	4.5	4.5	4.5	4.5	Blast.	5.	Blast.
Width of Grate.....	Feet.	5	5	5	5	5.	5.	5.
Area of Grate.....	Sq. Ft.	1,582	1,582	1,582	1,582	25	25	25
Water-Heating Surface.....	Sq. Ft.	138.2	138.2	138.2	138.2	138.2	138.2	138.2
Superheating Surface.....	Sq. Ft.	8.67	8.67	8.67	8.67	8.67	8.67	8.67
Smallest Area for Draft.....	Sq. Ft.	14.74	14.74	14.74	14.74	14.74	14.74	14.74
Area of Chimney.....	Sq. Feet.	105.	105.0	105.0	105.0	105.0	105.0	105.0
Height of Chimney.....	Feet.	70.3 to 1	70.3 to 1	70.3 to 1	70.3 to 1	70.3 to 1	70.3 to 1	70.3 to 1
Ratio Water-Heating Surface to Grate Surface.....		1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2
Ratio Air-Space to Grate Surface.....		1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2
AVERAGE PRESSURES.								
Steam Pressure in Boiler by Gauge.....	Lbs.	108.53	108.30	107.64	108.64	108.41	107.73	106.32
Absolute Steam Pressure.....	Lbs.	123.05	122.83	122.05	122.97	122.81	122.27	120.87
Atmospheric Pressure, by Barometer.....	In.	29.461	29.48	29.231	29.086	29.21	29.50	29.58
Force of Draft in Inches of Water.....	Lbs.	14.52	14.53	14.41	14.589	14.40	14.34	14.566
	In.	.24	.3025	.267	.261	.387	.351	.51
AVERAGE TEMPERATURES.								
Of Air.....	Deg. Fnh.	68.73	65.79	61.18	62.92	64.38	47.8	51.2
Of Fire-room.....	Deg. Fnh.	82.7	81.24	78.8	79.3	78.6	74.4	68.5
Of Steam.....	Deg. Fnh.	342.1	342.1	342.27	343.17	343.41	343.41	344.2
Of Escaping Gases.....	Deg. Fnh.	467	473.52	467.3	469	425.9	430.8	500.5
Of Feed Water.....	Deg. Fnh.	68.59	67.85	67.5	67.76	66.3	64.17	63.1

FUEL.			
Kind of Coal.....		Saginaw.	Hocking Val
Total Amount Consumed.....	Lbs.	6092.0	5808.5
Moisture in Coal.....	P.Ct.	5.5	.5
Dry Coal Consumed.....	Lbs.	5757.0	5518.08
	P.Ct.	4.2	6.1
Total Refuse	Lbs.	245.5	338.5
Total Combustible.....	Lbs.	5511.5	5179.5
Dry Coal Consumed per Hour.....	Lbs.	575.7	551.808
Combustible Consumed per Hour.....	Lbs.	551.15	517.95
RESULTS OF CALORIMETRIC TESTS.			
Quality of Steam.....		.9925	.9927
Percentage of Moisture.....	P.Ct.	.75	.73
ECONOMIC EVAPORATION.			
Water Actually Evaporated per lb. Dry Coal, Actual Temperature and Pressure.....	Lbs.	6.93	6.99
Water Evaporated per lb. Dry Coal from and at 212° Fahr.....	Lbs.	8.26	8.32
Water Evaporated per lb. Combustible from and at 212° Fahr.....	Lbs.	8.63	8.87
RATE OF COMBUSTION.			
Dry Coal Burned per sq. ft. Grate per Hour.....	Lbs.	25.5	24.5
Dry Coal Burned per sq. ft. Water-Heating Surface per Hour.....	Lbs.	.363	.34
RATE OF EVAPORATION.			
Water Evaporated from and at 212° per sq. ft. Water-Heating Surface per Hour.....	Lbs.	3.00	2.90
Water Evaporated from and at 212° per sq. ft. Grate Surface per Hour	Lbs.	211.04	204.1
COMMERCIAL HORSE-POWER.			
On basis of 34.5 lbs. Water Evaporated per Hour from and at 212° Fahr.	H.P.	137.9	133.2
Builder's Rating.....	H.P.	144.0	144.0
Cost in Coal to Evaporate 1,000 lbs. of Water from and at 212° Fahr.....	Cts.	14 $\frac{4}{10}$	15 $\frac{8}{10}$
Cost of Coal per Ton (2,000 lbs.)	\$&Cts.	2.25	2.50
Water Evaporated from and at 212° per lb. Wet Coal.....	Lbs.	7.80	7.91
Efficiency of Boiler	P.Ct.	71.10	

ANALYSIS OF SAGINAW COAL.

Volatile combustible matter.....	31.39
Fixed carbon.....	63.78
Ash.....	3.79
Sulphur.....	1.04
	100.00

By A. W. H. Linders, Analytical Chemist, Rockford, Ill.

Leases and Leasing.—During the past two years, and more particularly during the last twelve months, the chief occupation of “coal men” and speculators in coal lands has been to contract with land owners in all the best-known coal districts of the State for the right to test and explore for and mine and market any coal that may be found. The form of agreement used is, generally, concise and to the point, equally fair for both lessee and lessor. Some overcautious ones, however, took precaution against making a possible bad bargain, and sought security in verbiage by having them legally *drawn out*. The lessee usually agrees to commence prospecting upon the land within six months from the date of making the contract, and if coal is found, agrees to mine each year a stipulated quantity or advance the royalty on that quantity, if not mined at the expiration of eighteen months or two years the same as if mined. Payments for royalty are made quarterly, and the quantity paid for when mined is the same as that credited to the miners who excavate it from the land. The lowest amount per long ton agreed to be paid, that I know of, is four cents, and the highest eight cents. During the past year but few leases have been made for less than eight cents royalty, but the tendency is in the direction of lower prices, especially as coal lands are more remote from railroads.

In the early part of the year, at about the time when the coal find had been treated to a highly florid coloring, and excitement was running high, the rank and file of the competitors in leasing showed great skill in the art of *leasing* and but little knowledge of coal. Some iron-clad leases were executed by unsuspecting farmers, and a few I have seen were framed much upon the dictum: “heads, I win; tails, you

lose." One company early in the field, essayed to take possession of the earth and "the fulness thereof" under a coal lease—all the coal, kaolin, iron ores, oil, gas, stone, clay, water, and all minerals and ores in, upon, and under the lands, were to be surrendered if found. It was a case of "all is fish that comes to our net." What use is to be made of the water, do you ask? Unless to dilute prospective coal stocks, it is a question that must be begged. Its value, in common with the kaolin, iron ores, etc., was placed by the lessee at *nil*, which was hardly a fair appreciation of the good and useful things of the earth. It is pleasing to note that the advent of a number of responsible companies practising fair dealing has pretty well eliminated the shyster element from the field.

General Remarks.—Explorers seem to prefer making tests at and near populous centers, and while a vast amount of drilling has been done there, large areas inside the coal belt still await investigation. Cases have occurred in which valuable deposits eluded the drill of one explorer to be found by another; but whether these particular cases are due to imperfect appliances, or deceptions practised by the drillers, or haste on the part of the explorers, I am unable to say. All the earlier drillings and the reports which were made of them were more or less unsatisfactory and unreliable, but the machines and tools in present use seem better adapted to the work than formerly, and drillers have become more expert. The percussion drill is in general use.

There have been no fatalities in the mines due to the ignition of Light Carbureted Hydrogen Gas (Fire-Damp) or coal-dust. Once, while exploring the workings of a Michigan coal-mine, I encountered Carbonic Acid, or the deadly Choke-Damp; with this exception the mines opened to date may be said to be non-gaseous. Falls in all countries where mining is carried on, are the most prolific of fatal accidents; but the greatest number which have occurred in the coal-mines of this State, of recent date, were the result of careless handling of explosives.

I have made one trial, in the survey of a mine, of acetylene gas for illuminating purposes, and am pleased to say it proved highly satisfactory.

Mining Laws.—While the ventilation is good, the timbering sufficient, and the sanitary condition fair in existing coal mines, the one desideratum, an escapement shaft, within a year after the main shaft is sunk, should be insisted upon by legislative enactment. It is not too early now to turn our thoughts toward mine legislation; there is a growing popular demand for it in this State, and it is recognized by all mine operators, as well as others, with whom I have discussed the subject, that this society is qualified in many ways to formulate a good mining law. The existing laws are inadequate to meet the requirements of coal-mining operations, and responsible operators have expressed the wish that this society will use its influence, at an opportune time, to secure the passage of a good mining law. An abundance of material can be had in this country to aid and guide us in framing such a law. One dozen States have laws regarding coal mining which provide for sanitary regulations, timbering, safe working of the mines, and inspection by a competent person. Our near neighbors of Ohio, Illinois, and Pennsylvania have, I think, the most comprehensive laws on the subject, and contain all necessary details. The reports of the Ohio inspectors of mines carry a strong conviction that the mining laws of that State are strictly enforced, and that underground is carried out with consummate skill. We can not do better than pattern after them. The best authority that I know of on the subject of practical mining laws is Mr. Edmond G. Arndt, civil and mining engineer, who for a number of years has been an inspector for several of the large Casualty Companies who were doing an Employers' Liability business. At their request he made a report last year to the Bureau of Statistics and Arbitration of the Casualty Companies doing business in the United States. In his report, among other things, he mentions the result of his inspections of coal-mines. He says: "The coal-fields of Ohio have no deep shafts, are not gaseous (except about thirty-six mines), are more frequently worked by drifts and slopes than those of any other State, are under the most reliable and experienced State inspection of any coal-fields in the Union, in that there is a well-organized State Mining Bureau, under the direction

of an experienced and scientific chief inspector, who is not harassed by political interference, and has the direct supervision and direction of a practical corps of district inspectors."

"The mining laws of the State of Ohio are similar to those of Pennsylvania, are based upon the mining laws of Great Britain, and are strictly enforced. Child and female labor is provided against, and the duty of operators is clearly defined."

"Ohio has had no serious mining disaster as in other States. Explosions are of rare occurrence, and the inundation of mines is unknown. Casualties have been confined mostly to causes incidental to the occupation, and disregard of employees for established rules."

"The statutory requirement regarding the supply of timbers for working places is strictly complied with, and not waived as in some other States."

"The ventilation of 100 cubic feet of air per minute is enforced, and a monthly record of the same submitted to the chief mine inspector. I have generally found the air in excess of the required volume."

I believe all that Mr. Arndt has written of the Ohio coal-mines, and their inspection is true, and but one exception can be taken. Five months prior to the date of his report, one mine was inundated. It occurred in Harrison County, and was due to a cloudburst. The mine was filled with water which rushed down the valley, but fortunately the miners were not at work.

If, gentlemen, you should decide to invoke legislation for the protection of ourselves and the miners in the performance of the hazardous duties incident to mining, I would advise that our legislators be urged to be mindful for the interests alike of the employee and the employer; and while the former is duly protected by law, the latter should not be hampered with arbitrary enactments, but rather encouraged, as far as legislation can, to develop this new industry of coal-mining in Michigan.

THE PRESIDENT: Mr. Holmes is entitled to the thanks of the society for the careful preparation of so valuable a paper.

MR. RIGGS: Although I do not know much about mining, the question has frequently been asked me in the past year or

so, how Michigan coals compare with Ohio and West Virginia coals as State coals. I know that tests of the same qualities of these coals have been made at the Pontiac Asylum under the direction of Mr. Pierson and Mr. Ames ; and I would like to ask whether any of the water-works people here have made any similar tests.

MR. BRIGDEN : I don't know that any tests have been made by the water-works people, but the railroad people have made some tests, and I understand from the Grand Trunk people that they have so far tested the Jackson coal as to reject it as unsuitable for such severe work as they have on their locomotives. I am not sure but it would do for a water-works plant that was not rushed ; but I think it would hardly do for a plant that required a strong fire.

MR. RIGGS : I haven't the figures in mind ; but my recollection of the Pontiac Asylum tests is that for their uses the coal mined at Saginaw and St. Charles compared very favorably with most of the Ohio coal, ranked with the better grade of Ohio coal according to Dr. Pierson's report. I know this report surprised me very much, and I should like very much to know whether there are any other tests available.

PROF. WEIL : I think it is admitted that the calorific value of our Michigan coals is practically equal to that of Ohio coals. A number of tests have been made at the University, and at the Agricultural College. Some made at the Agricultural College were comparative tests in every sense of the word, the same boiler being used, and the conditions in every way being practically identical. The Ohio coal was given a certain trial, and then the Michigan coal was given a similar trial, under the same identical conditions, and we found the calorific value to be about the same.

MR. GRANVILLE : The statements made in Mr. Holmes's paper will probably answer Mr. Riggs's questions, but they need considerable study. Here is a comparison of the Saginaw coal with the Wells Creek coal or that used by the Grand Trunk road, and a description of the two coals, etc. The table gives all these things.

MR. VINCENT : In the discussion of coal the point naturally

comes up as to what would be the commercial or market value. But there are some of you here that are interested in the light of the home, and would like to know whether this is suitable for use in the house. Is there any one here who has used it? Perhaps the gentleman from the college can tell us if they use it in the University at all.

MR. WALKER: The point before us now, as I understand, is the value of Michigan coals as compared with Ohio coals. Theoretically, I don't know anything about it. We are using in our business about a car a week, and in such a way as to be able to tell where to get our coal to do the work with the least money; in other words, the amount of work we are doing with a certain number of dollars; and we find the Ohio coal lasts us longer; that is, we do our work longer in running the water-works. You understand it is no trick at all to tell the different merits of two cars of coal of the same weight. We are also running a shop where the conditions are entirely different. In both cases we have got plenty of water. The coal we use at our shop we find altogether the cheapest coal, and that it answers our purpose quite well, while we would not dare use it at all at the water-works. We are in pretty near the same shape when we use any Michigan coal at the water-works for this reason: That for our every-day work we don't work our boilers to more than twenty-five per cent. of their capacity, and get along pretty well with most everything under these conditions. We are liable to have a fire alarm, and want to work all our boilers within five minutes to beyond their capacity, and we could n't do it with Michigan coals. For that reason we can not use them. I mention these things to show that in some cases it might pay us well to use Michigan coals, and in many it will not. We, of course, figure our coal at what it costs, laid down there. Conditions might be entirely different in some other part of the State.

DERIVATION AND APPLICATION OF A USEFUL AND CONVENIENT AZIMUTH FORMULA.

JOHN G. MOELROY, BRECKENRIDGE, COLO.

IN compliance with instructions issued by the commissioners of the General Land Office, the surveyors-general of the United States require their deputies to deflect all bearings in surveys for patent, from the *true meridian*. This is universally understood to be simply an elliptical way of stating that, in such surveys, the bearings incorporated in the field notes transmitted by the deputy to his surveyor-general shall be *true* as distinguished from *magnetic* or any other *approximate* bearings. The initial deflection may or may not be made from a *true meridian*,—usually it is *not*; for the surveyor, actuated by considerations of convenience, frequently selects one of the longer lines of his survey as a line from which to make the first deflection. Still more frequently the line adopted is determined by a station of the survey and some very distant point entirely unassociated therewith. The line having been selected, and its true bearing determined, the bearings of all lines of the survey are thence found by successive deflections.

Of the various methods at the disposition of the surveyor for the determination of true bearings, the most accurate (and least used) is to observe the north star, Polaris, when at elongation; then having the star's azimuth from

$$\sin z. = \frac{\sin p}{\cos l}$$

(where z , p , and l are respectively the star's azimuth, its polar distance, and the observer's latitude), the surveyor may perpetuate, for future reference, either his meridian, or a line deviating therefrom by the amount of the stellar azimuth.

This method gives extremely accurate results, for the angular distance of Polaris from the pole is always small; moreover the star's motion in azimuth, when approaching elongation, is very slow, and hence no great precision in the matter of *time* is necessary; but the method is rarely practiced, for the reason

that during the major portion of the year the visible elongations occur at inconvenient times. It has thus transpired that the surveyor of to-day depends almost entirely on solar observations for his bearings. He proceeds in either of two ways. First, by the use of one of the various *solar attachments* now manufactured, he places the line of collimation of his transit in the plane of the meridian, which thus at once becomes the plane from which to make the initial deflection. Secondly, he solves the *astronomical triangle* for the angle at the zenith (the data being the sides of the triangle), and thus finds the sun's true bearing at the instant of observation; combining this with the angle from the sun to the assumed line, he finds the true bearing of the latter. The computation implies a knowledge of the sun's altitude and declination, and of the observer's latitude, for the sides of the triangle are the complements of these quantities; the sun's altitude is measured by the observer, the declination is taken from the *Ephemeris*, and, in this era of accurate maps, the latitude is usually *scaled*,—it being sufficiently precise to allow *one second* of arc for each *100 feet* of northing or southing from a point of *known* latitude. We may observe, parenthetically, that, should there be no reliable maps at hand, the surveyor readily finds his latitude by algebraically combining the polar distance of Polaris with his altitude when on or near the meridians,—the true local mean time, as distinguished from *standard* time, of the upper meridian passage being first computed by subtracting the right ascension of the meridian at mean noon of the date of observation from the right ascension of Polaris,—adding 24 hours to the latter when necessary to render the subtraction arithmetically possible,—and reducing the resulting interval of sidereal time to its mean time equivalent. The data for this reduction,—the right ascension of the meridian at mean noon, and the right ascension of Polaris,—can be found from the American Ephemeris and Nautical Almanac, with which the surveyor should always be equipped. When near the meridian, Polaris moves very slowly in altitude, and hence in this observation for latitude the observer has ample time, and may proceed with care and deliberation, since it is not essential that

he should "snap" the star when exactly on the meridian,—the ability to do this would, in fact, imply a knowledge of that which he is seeking—the position of the meridian. It is pertinent to observe that the mean times of the elongations of Polaris are readily found from the mean time of his upper culmination, as computed above, by combining therewith the mean time value of the star's *hour angle* at elongation,—the sidereal value being given by $\cos P = \tan l \tan p$, where P is the star's hour angle, p its polar distance, and l the latitude of the observer.

While there is something to be said in favor of each of the above cited methods of solar observation, the fact is that the second or *direct* method, as exemplified in the use of colored eye pieces, ground glass screens, diagonal prisms and *plain pasteboard cards*, is rapidly supplanting the use of the more costly appliances designed to effect an expeditious determination of the meridian through the medium of what is virtually a mechanical solution of the *astronomical triangle*. Of these mechanical devices the first was brought out by Burt, of Michigan, in 1836. In its present form it is, by many engineers, considered the most convenient and desirable contrivance yet devised for quickly finding the meridian from a co-ordinate determination of the sun's position (in this opinion, however, the writer does not concur). In our own experience the results obtained by direct observation and subsequent computation are more consistent and satisfactory than those given by any mechanism yet proposed for the use of the surveyor. The only objection advanced against the method is that it renders necessary a certain amount of computation that is eliminated by the use of the "solar,"—the latter demanding simply a table of the sun's declination for the various hours of the day. This is true; but in the light of experience it is not generally conceded to be an objection of much weight, for the computations complained of are, when properly made, neither intricate nor tedious; moreover, it seldom occurs, in practise, that a knowledge of true directions is necessary during the prosecution of the earlier portions of the field work; should such a necessity arise, it could be met, without materially retarding the progress

of the survey, by the reduction in the field of a few "readings." In fact, the plan adopted by many deputy mineral surveyors is to begin the survey with an approximate course,—frequently a mere needle course; the sun readings are afterward taken at such times and places as best subserve the requirements of accuracy, and leisurely reduced in the office: there is thus obtained a constant correction that is easily applied to the previously deflected but approximate courses.

Surveyors usually reduce their sun readings (observations) by using either the well-known expressions for the trigonometrical functions of half the sun's azimuth angle, or a formula involving the use of arcs auxiliary to the astronomical triangle. These methods are simple, easily applied, and by no means laborious; but, still further to simplify and systematize the reductions, the writer would propose the use of the expression, —

$$\cos Z = \pm \frac{\sin d}{\cos l \cos a} \mp \tan l \tan a,$$

which is simply a modification, by himself, of one of the fundamental equations of spherical trigonometry.

Before illustrating the utility of the formula and the facility with which it may be logarithmically reduced, it will be proper, for the sake of completion, to give the argument on which it rests. To this end let PZS , Fig. 1, be a spherical triangle, and K an arc of a great circle drawn from Z perpendicular to PS ,—(or to PS produced).

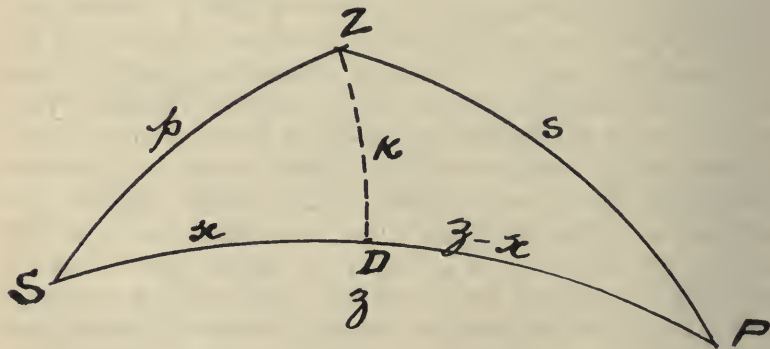


FIG. 1.

sider Fig. 2., which represents the four astronomical triangles PZS , PZS' , $P'Z'S$, and $P'Z'S'$, projected on the plane of the meridian $PNHZ$. In A. M. observations the azimuth angles at Z or Z' will be estimated from the north to the *right*; in P. M. observations from the north to the *left*.

We adopt the following notation:—

PP' = axis of the celestial sphere.

P = the celestial north pole.

P' = " " south "

EQ = " " equator.

HO^1 = the celestial horizon of which the poles are Z and N .

Z and N = zenith and nadir of an observer in north latitude.

Z' and N' = " " " " " " " " south "

$EZ = l$ = observer's latitude when at Z .

$EZ' = l =$ " " " " " " Z'

S = the sun when north of the equator.

S' = " " " south " " "

$VS = d$ = " suns' declination when north.

$VS' = d =$ " " " " south.

PS = the sun's north polar distance when north

$PS' =$ " " " " " " south.

$MS = a =$ " " altitude " " north.

$MS' = a =$ " " " " " " south.

$pp' =$ " " daily path " " north.

$p_1p_2 =$ " " " " " " south.

It will be sufficient to consider the *particular* case of an observer in north latitude, and the sun in north declination (whence d and l are *positive*; a is *always* positive), and then make our results *general* by properly observing the signs of d and l .

The case assumed is illustrated by the triangle PZS (Fig. 2), in which—

$$PS = 90^\circ - VS = 90^\circ - d,$$

$$PZ = 90^\circ - EZ = 90^\circ - l,$$

$$SZ = 90^\circ - MS = 90^\circ - a,$$

and the sun's azimuth angle PZS is required. It is found thus: By applying the principle of which equation (5) is the enunciation to the angle PZS , we have

¹ The horizon of which Z' and N' are the poles is not shown in the Fig.; it would be projected as a diameter perpendicular to $Z'N'$.

From this,—

$$\cos Z = \frac{\sin d}{\cos l \cos a} - \tan l \tan a. \quad (6)$$

In (6) $\cos l$, $\cos a$, and $\tan a$ are always positive, but $\sin d$ and $\tan l$ will respectively have the signs of d and l ; hence to prevent mistakes it is advisable to write the expression in the form:—

$$\cos Z = \pm \frac{\sin d}{\cos l \cos a} \mp \tan l \tan a, \quad (7)$$

which is the desired solar formula.

With respect to the signs of the formula the surveyor has simply to remember that the first term of the second member

is $\begin{cases} + & \text{for north declinations,} \\ - & \text{for south declinations;} \end{cases}$

and that the second term—

is $\begin{cases} - & \text{for north latitudes,} \\ + & \text{for south latitudes.} \end{cases}$

For north latitudes the formula always gives *negative* values for $\cos Z$ when the declination is *south*, and also for such *north* declinations and values of a as render $\sin d < \sin l \sin a$; but when $\cos Z$ is *negative*, Z is greater than 90° , and hence the *positive* value of the cosine, as taken from the tables of “Naturals,” is the cosine of $(180^\circ - Z)$ (*i. e.*, of $E Z S$, the azimuth from the *south*), for $-\cos Z = \cos(180^\circ - Z)$.

The reduction of the following set of readings taken by the writer in latitude $38^\circ 47' 50''$ N. (as scaled from a reliable map), longitude $105^\circ (= 7 \text{ hours})$ west of Greenwich, on Dec. 15, 1896, at 10 A. M., will illustrate an expeditious and convenient manner of arranging the computations incidental to the use of the formulas.

Angles *left* from the sun—

to an assumed distant point.

Sun's observed altitudes.

51° 14'		23° 12'	} — 2' 10'' for refraction.
“ 23'		“ 15'	
“ 30'	Lat. = 38° 47' 50'' N.	“ 18'	
“ 35'	Long. = 105° West.	“ 20'	
“ 42'	Time = Dec. 15, 1896, 10 A. M.	“ 22'	
“ 46'		“ 24'	
“ 52'		“ 26'	

In this set of observations the horizontal angles were turned to the sun from an assumed distant point to the left thereof; hence, although they were *measured* to the *right*, they are

properly *recorded* as angles to the *left*; for the sun is the object of reference.

From the above set of readings it appears that the field work consists simply in the measurement of horizontal and vertical angles.

After "setting up" (preferably over a station of the survey) it is advisable to deflect to the sun from a point so distant that the focus of the object glass need not be changed when the telescope is turned up to the sun.

With the aid of an assistant to record the angles, and under the favorable conditions of comfortable weather and non-interruption by clouds, the writer finds that a continuous set of ten or twelve complete readings will be taken and recorded in about ten minutes; hence, since we need the element of *time* simply as a factor in computing the declination, and since the change in declination never amounts to ten seconds of arc in ten minutes of time (the greatest change being at the equinoxes, where it is less than one minute per hour), it is sufficient to compute d (the declination) for a time midway between the times of the first and last observations. Such a mean time for the set of readings given above is, as there stated, 10 A. M., which, for the given date and longitude, gives $d = 23^{\circ} 19' 52.5''$. (See the Ephemeris.) Again: the existing tables of refraction,—Bessel's and Young's,—have been computed on the assumption of the prevalence of certain barometrical and thermometrical conditions, any pronounced deviation from which necessitates the application of *corrections* which may not be ignored in the refined operations of the astronomer, but may be safely neglected in the comparatively coarse work of the surveyor. Moreover, when a continuous set of observations is quickly taken, the change in refraction during the elapsed period will be very slight, and therefore it becomes admissible to apply to each altitude the refraction corresponding to the *mean* of the altitudes. In our case the mean altitude is $23^{\circ} 20'$, and the refraction, according to Bessel, is $2' 13''$; ignoring the odd $3''$ as a slight deference to the rights of parallax, we have $2' 10''$ as a constant subtractive correction to be applied to each of our altitudes. In this connection it is well to remark that since the refraction and parallax corrections are in opposite

directions, the effect of the latter — the parallax — is to diminish the former; the diminution will always be slight, for the solar parallax is only about 9" in the horizon, and decreases as the cosine of the observed altitude; and since the surveyor generally uses tables giving the trigonometrical functions to 10" intervals, he will not only avoid all interpolation by dropping from his tabular refraction such a number of seconds as will reduce the number remaining to the nearest multiple of ten, but will also sufficiently recognize the element of parallax.

Let us now reduce our seven observations, first writing the computation, and afterward adding a few explanatory remarks.

Since the observations were taken in *north* latitude, with the sun in *south* declination, our formula, as previously explained, will be—

$$\cos Z = -\frac{\sin d}{\cos l \cos a} - \tan l \tan a, \text{ where } d = 23^{\circ} 19' 52.5'', l = 38^{\circ} 47' 50'',$$

and the successive values of a are those of the preceding list diminished by $2' 10''$. We see at a glance that $\cos Z$ will be *negative*, and hence that Z will be greater than 90° ; and since Z is estimated from the north to the *right* in the morning, (from the north to the *left* in the afternoon), the sun was in the south-east quarter of the heavens, and hence its bearings, as given by the formula, will be marked $S - E$. The computation is conveniently arranged as in table on next page.

This arrangement gives 12 horizontal lines, each of which, beginning with line 1, is to be *completed* before passing to the next in order, as per the following explanation:—

Since $\frac{\sin d}{\cos l}$ and $\tan l$ are *constants*, the logarithm of each is written as many times as there are observations,— as in lines 1 and 2; the balance of the work consists in subtracting the log-cosines of the *corrected* altitudes (line 3) from the constant of line 1, adding their log-tangents (line 4) to the constant of line 2, taking out the numbers (lines 7 and 8) corresponding to the resulting logarithms (lines 5 and 6), and combining these numbers according to their signs; thus obtaining a series of values (line 9) for what, when taken with the + sign, are (in this case) the natural cosines of $(180^{\circ} - Z)$, the sun's azimuth

* $\log \sin d$ $\log \cos l$	9.5977460 9.8917428	— 1.7060032	— 1.7060032	— 1.7060032	— 1.7060032	— 1.7060032	— 1.7060032	 1
$\log \frac{\sin d}{\cos l} = \text{constant}$	— 1.7060032	9.9633343	— 1.7060032	9.9631716	— 1.7060032	9.9630629	9.9628449	 3
$\log \cos a =$	9.9634967	— 1.7426089	— 1.7428316	— 1.7429403	— 1.7430492	— 1.7431583	— 1.7432675	 5
$\log (\sin d + \cos l, \cos a) =$	— 1.7425065	— 0.5529283	— 0.5531356	— 0.5532741	— 0.5534128	— 0.5535518	— 0.5536910	 7
$\sin d + \cos l, \cos a =$	— 0.5527217	— 0.3448002	— 0.3456311	— 0.3461854	— 0.3467401	— 0.3472949	— 0.3478500	 8
$\tan l, \tan a =$	— 0.3439654	— 0.8977285	— 0.8987067	— 0.8994395	— 0.9001529	— 0.9008467	— 0.9015410	 9
Nat cos Z	— 0.8966871	S. 21° 08' E. 51° 23'	S. 20° 00' E. 51° 30'	S. 25° 55' E. 51° 35'	S. 25° 40' E. 51° 42'	S. 25° 44' E. 51° 46'	S. 25° 38' E. 51° 52'	 10
Sun's Bearing — 180° — Z	S. 20° 16' E. 51° 14'	S. 77° 31' E.	S. 77° 30' E.	S. 77° 30' E.	S. 77° 31' E.	S. 77° 30' E.	S. 77° 30' E.	 11
Angles left from sun								 12
Bearing of assumed line =	S. 77° 30' E.							
Mean result = S. 77° 30' E. 13								
Constant log = $\log \tan l$	9.9052241	9.9052341	9.9052241	9.9052241	9.9052341	9.9052341	9.9052341	 2
" " " " " " " "	9.6312963	9.6323434	9.6332887	9.6340847	9.6347799	9.6354743	9.6361679	 4
$\log (\tan l \tan a) =$	— 1.5365204	— 1.5375675	— 1.5386128	— 1.5393088	— 1.5400040	— 1.5406984	— 1.5413920	 6
$\tan l \tan a =$	As given in line 8.							

* In practice the first members of these equations will not, of course, be written,—familiarity with the formula rendering them unnecessary.

from the *south*; each value thus found (line 10) is combined with its proper “angle *left* from the sun” (line 11), thus finally giving us a series of determinations (line 12) for the required bearing of our assumed line,—the line fixed by the transit station and the assumed distant point; from this bearing the bearings of the lines of the survey are found by successive deflections.

When the results (line 12) are satisfactorily accordant, their *mean* to the nearest minute (line 13) is used; but should one or more of the results be unduly in error the fact will be emphasized by an inadmissible divergence from the majority of the results; when this happens, such discordant ones are to be discarded, and the mean of the others assumed as the correct result. In fact, the reason for taking a *series* of observations is that no *single* observation is trustworthy; hence it is not good practice to rely on a *mean computation*; *i. e.*, on a single computation involving the mean of the data; for, if some of the data are in error, their mean is in error, and a result based on such a mean is likewise in error. The astronomer, working at his ease and leisure in his fixed and comfortable observatory, may and does proceed in this fashion; but the environments of the astronomer and surveyor are by no means similar; the conditions under which the work of the latter is conducted are frequently such as to render it probable that some of his notes will be tinctured with error; for, if he is not mentally calm and physically comfortable (usually he is not), he is liable erroneously to read or record one or more angles. Hence he should take a *set* of observations, reduce each one of the set, discard such results as are evidently in error, and use the mean of the others. Moreover, he should not rest content with *one* set, but should check his work with various sets taken in various places, and at both A. M. and P. M. times.

For the purposes of the surveyor, nothing is gained in precision by taking half the readings with the transit *reversed*, provided it is in good adjustment, as it always should be; should it be materially out of adjustment, the operator should not fail to take the mean of at least two sets of readings (one set taken in the morning and the other in the afternoon), using the instrument in direct and reversed positions in each case,

and taking the two sets with the sun about equally distant from the meridian.

After a little practice, the results obtained by receiving the sun's image on a plain, white card, held behind the eyepiece, will be found perfectly satisfactory. The readings reduced above were taken in this way, the instrument used being a Buff and Berger No. 2 transit; it has five inch circles, an inverting eyepiece, and is read to minutes; the optical properties of the lenses are such that the image of the sun's disc, as thrown on the card, is about 0.3 inch in diameter, a size the eye finds no difficulty in quartering by means of the image of the cross wires. The images of the sun and wires, as given by this instrument, are beautifully clear and distinct when the object glass is focused for solar distances, and the eyepiece drawn out nearly as far as possible.

In the examples given, the mean of the seven results is *S. 77° 30' E.*; and, in this particular case, practically the same result is obtained by a single computation based upon the mean of the data; but generally, as before stated, this is not good practice; it is, however, perfectly admissible to use a refraction corresponding to the mean of the altitudes, for, at such times of the day as should be chosen for observation purposes, the refractions are so small and change so slowly that any altitude error capable of sensibly affecting such an assumed *mean* refraction would be glaringly apparent, and the record of the corresponding observation canceled. The refraction of bodies when in or near the horizon is not only enormous, but uncertain; hence the surveyor should not take the sun at such times, but should wait until the luminary is well in the heavens; nor should the sun be taken when near the meridian; for though the vertical component of his motion is then very small, the horizontal component is very large; hence, although the instrument might be in excellent adjustment, and the *vertical* angles (altitudes) properly measured, the *horizontal* angles from the assumed distant point to the sun would be vitiated by an element of uncertainty, due to the latter's rapid motion in azimuth. For the purposes of the surveyor the times best for observing, in the central latitudes of the United States, are about the middle of the forenoon or afternoon; that this assertion is

warranted by a comprehensive analysis of all elements and conditions affecting the problem, the writer is not just at present prepared to assert; he simply knows, from his own experience and the experiences of many others, that the computed azimuths are most satisfactory (because most accordant) when the observations are taken at these times.

In conclusion it may not be amiss to observe that in order fully to realize the superior convenience of equation (7) in the reduction of *sets* of observations, as compared with other formulas proposed and used for the same purpose, the computer should take out $\cos l$ and $\tan l$ at one search, and likewise $\cos a$ and $\tan a$; then having written the equal quantities of line 1 as one operation, those of line 2 as another, and formed lines 3, 4, 5, and 6, he should complete lines 7, 8, 9, and 10 in the order given (for the quantities in each of these lines will generally be found on two or three consecutive pages of the tables), and finish the work by successively completing lines 11 and 12, and computing the mean result.

Equation (7), in somewhat different shape, is familiar to mathematicians and astronomers, but has never, to the knowledge of the writer, been properly brought to the notice of engineers and surveyors. The reader will not fail to observe that the greater facility with which it may be applied to the reduction of sets of observations, as compared with even the most convenient and expeditious methods of handling the various expressions for $\frac{1}{2}Z$, is due not only to the elimination of the radical sign and all complementary arcs, but especially to the occurrence of the constant factors $\frac{\sin d}{\cos l}$ and $\tan l$,—thus leaving but the two variables $\cos a$ and $\tan a$, which are near neighbors on the same page and line, of the tables; whereas, in such an expression as, for instance,—

$$\cos \frac{1}{2}Z = \sqrt{\frac{\cos \frac{1}{2}s \cos (\frac{1}{2}s - p)}{\cos a \cos l}},$$

$\cos a$, $\cos \frac{1}{2}s$ and $\cos (\frac{1}{2}s - p)$ are variable, and usually will be found at widely separated portions of the tables. Moreover, any inaccuracy or error in $\frac{1}{2}Z$, as found from such formulæ, is *doubled* in the corresponding value of Z .

THE TOPOGRAPHICAL SURVEY OF THE DETROIT RIVER.

HARRY HODGMAN.

THIS survey was made under the direction of Col. O. M. Poe, corps of engineers United States army, during the years 1894 and 1895, by Mr. Herman Kallman, Jr., United States inspector.

The object of the survey was to secure information which would aid in navigating the stream. A system of triangulation was first laid out, and stations erected and located. All angles were read by the repeating method; *i. e.*, each angle was added to itself instrumentally several times. The sum then being divided by the number of repetitions gave much closer results than would have been obtained from a single reading. To eliminate as far as possible all instrumental errors, several sets of these observations involving different methods were taken to determine each angle, such as reading both verniers each time, using the telescope first at normal and then inverted, and reading from different points on the limb. The mean of these several results gave a very accurate determination of the angle. The instrument used throughout the entire survey was a Buff and Berger transit reading to ten seconds.

After the field work of the triangulation survey was completed, the triangles and quadrilaterals were adjusted, and the sides, co-ordinates, and azimuths were computed, as was also the geodetic position, or the latitude and longitude of each station.

Having then a base or framework upon which to drape the topography, the field work of taking the same was begun. This part of the survey was made entirely by the stadia, and gave very good satisfaction. The party consisted of a transitman, or observer, a recorder, a topographer, two or more rodmen, and a boatman. The party having been formed, the survey was begun at a triangulation station. The observer having set

his instrument to read azimuths, would then have his rodmen hold their rods upon each distinguishing feature of the surrounding country within distance from the instrument. The azimuth and distance to each from the observing station was recorded, each point being numbered. As the survey proceeded, the topographer made pencil sketches of the vicinity in a book suitably designed for it, showing by topographical signs the kinds of land, the fences, buildings, water lines, etc., and indicating the stadia points by numbers corresponding to those in the book of the recorder. Having located all the prominent points within reading distance, another stadia station was selected in a desirable position, and located by the stadia. The observer then moved his instrument to this new station, determined his azimuth from the last station, and proceeded as before. This was continued until the survey was closed on the next triangulation station. Thus the survey was continued from triangulation station to triangulation station until the work was completed.

The rapidity with which work can be done in this manner depends largely upon the nature of the country and the number of rodmen used. The banks of the Detroit River are quite thickly settled, so there were many buildings, fences, etc., to locate. A territory about a third of a mile wide along the shore was covered at a rate of one and a half to three miles per day. With the party described, everybody was busy, and all worked to advantage. At times the transitman and recorder were hurried by the rodmen; at other times the rodmen would have to hurry; but the topographer found it necessary to hustle all the time. When opportunity permitted of so doing, the topographer would sketch as much of the ground as possible before the remainder of the party came on to the field.

The purpose of the survey was to locate all the distinguishing features of the land bordering on the stream. Fences were determined by locating two or more points along their line; buildings, by locating two or more corners (the topographer giving the dimensions), the shore lines, boundaries of marshes, wood land, rushes, streams, cultivated and uncultivated lands, etc., by locating the contours bounding them.

Stadia stations were usually from five hundred to twelve hundred feet apart; much more accurate work was done, however, when stations were selected not over eight hundred feet apart. Rods fourteen feet long permitted of readings being taken a total distance of twenty-eight hundred feet, where the whole length of the rod could be seen, but as a rule readings were seldom taken at a distance of over eighteen hundred feet.

Field work being completed, the office work consisted of adjusting the stadia survey to correspond with the triangulation, and of plotting the survey. Usually after computing the co-ordinates of the stadia stations, it was found that in traversing a distance of two or three miles between triangulation stations, the stadia survey would disagree with the triangulation by as much as five to twenty feet (seldom less than the former). In closing the survey in the field the azimuths usually checked out very closely (ordinarily within a minute), showing that the main source of error was in reading the rod, therefore the stadia survey was adjusted by the ordinary method of correcting the sides of a polygon. The co-ordinates were then recomputed. No special correction was made for focal distance, etc., as it was not thought that extreme accuracy was necessary in a survey for the purpose of aiding navigation only.

A centrally located triangulation station was used as point of origin in computing the co-ordinates of triangulation and stadia stations. These stations were plotted by the co-ordinate system, and then the topography from each stadia station was plotted directly from the field notes of the observer and the sketches of topographer.

The following is a sample page of transit-book, showing method of keeping notes : —

TOPOGRAPHICAL SURVEY OF DETROIT RIVER BETWEEN $\triangle$ PTE.MOUILLEE AND $\triangle$ CLAY BANKS ON AMERICAN

SHORE. DEC. 1, 1895.

AT $\triangle$ PTE. MOUILLEE.		 Observer.	
		 Recorder.	
No.	Object.	Dist.	Azimuth. Remarks.
	$\triangle$ Bar Point		A220°50'30''
	Detroit River L. H.		A232 47 25
	Catholic church spire		A209 06 40 at Amherstburg Ont.
1.	Pt. on shore	80	326 10 30
2.	Shore and fence	277	330 40 20
3.	Pt. of woods	893	4 16 15
4.	Fence line	1013	78 15 40
5.	S. E. Cor. house	649	180 15 10
6.	S. W. Cor. house	650	175 16 30
7.	Shore line	400	196 17 15
	$\square$ (Stadia station) No 1	797	A182 23 50
	"		B 2 23 50
AT $\square$ No. 1.			
	$\triangle$ Pte. Mouillée		A 2 23 50
	"		B182 23 50
	$\triangle$ Bar Pt.		A230 19 15
	Catholic church spire		214 17 40 at Amherstburg
8.	Pt. on shore	200	175 16 10
9.	N. E. Cor. barn	160	100 16 50
10.	S. E. Cor. barn	159	86 15 50
11.	Edge of marsh & upland	1577	97 47 20

INSPECTION OF U. S. SURVEYS OF PUBLIC LANDS.

A. W. BARBER.

GOVERNMENT surveys may be loosely classified as ancient and recent, in order to refer to certain differences among them. The old lines were usually run by upright and faithful men, hindered or handicapped by crude instruments, loose and unscientific instructions, and limited professional knowledge. The modern lines have often been established by surveyors capable of precise work, using fine instruments, under exact instructions, yet so eager for the profits to be made by slighting their duties in every way, that the results have been generally discreditable, both to the surveyor offering such service and the government accepting it.

A third sort of work has also existed from the beginning of the system, executed by men whose genius and whose honor were superior to all obstacles, and whose name attached to field notes of any period is a high guarantee of general accuracy.

In the half-way recent decades, scandalous revelations were made from time to time, proving that the corruption and collusion practiced in different districts by some of the surveyors general and their deputies, against the General Land Office and the public, were of an extensive and dangerous sort; that many a township platted and paid for, had never been surveyed; that gross errors and omissions pervaded others; and that official plats had come to be no guarantee whatever to the settlers that corners, lines, and acreage would be found as represented.

The system was therefore amended by adding the practice of inspecting the field work before acceptance and payment. To the ordinary business man it may seem a piece of inexplicable looseness, to use a mild term, that this was not done during the first sixty or seventy years of the government. But due allowance must be made for the poverty of the country, the credulity of officials at the capital, the political scheming of the frontier, and especially the fact that in those days the survey-

or's profession was held too honorable to permit suspicion of deliberate falsification of field notes.

A great contrast is therefore evident, between the old practices and the recent inflexible rule that at least ten per cent. of the lines of each township must be carefully rerun, and full field notes thereof returned to the Department, by a competent examiner, before the deputy surveyor's returns will be taken up for final action and settlement of account. The delays caused by this condition are often a hardship to the deputy; but the old evils of hasty and inconsiderate action have made it necessary.

Under this stringent requirement it has been the writer's privilege to spend four seasons in the work of an examiner, being detailed from office work to field service by reason of the urgent need of more inspectors than the limited number of "special examiners" authorized. Omitting any account of previous work with a pack-train outfit in the wilds of the Rockies, I will outline the work as carried on, from May to November, 1898, on the great Sioux reservations of 'South Dakota. Since different examiners may vary in their practice, the account must be limited to my own methods, and given in the first person.

First, at the surveyor general's office I am furnished with an outline plat or sketch of each township to be inspected, showing length and course of all lines, and position of leading topographical features, such as water courses, roads, and hills, but without field notes or description of corners. After fitting out at some frontier town with one or two teams and covered wagons, with tents, bedding, provisions, camp stove, and all camp necessities, with two chainmen, a flagman, and a teamster who is also camp-keeper and cook, we journey for days across the prairie to the deputy's work, and search for a camp with wood, water, and grass, near to one of his corners; and in some parts of the "Great American Desert," it is a hard matter to find such a camping spot in the season of drought and prairie fires. To avoid being without firewood and water when journeying into regions of probable scarcity, the kegs are filled and dry wood loaded on, before starting.

A section corner having been found, the transit is set over

it at the proper time for an observation of Polaris for true meridian, preferably at elongation, sometimes at culmination, but when clouds prevent these, then at any hour by the less convenient hour-angle method. To insure the correct projection of the star to the horizon, the transit is most carefully leveled by the telescope level. A lantern is used to illuminate the vertical wire with the star; but by removing the light and placing the glass a trifle out of focus, the star becomes a small blur, which the cross-hair is seen to bisect when exactly in line, thus verifying the less precise lantern sight.

Pegs are then set in line, distant two to five chains both north and south, with points or tack-heads shown by the lantern in proper place, and the transit is removed, leaving the tripod firmly keeping the exact point used. Next day the proper azimuth is set off, and a true meridian established, which becomes the basis and test of the courses of any lines I may run in that vicinity.

By this meridian the magnetic declination is usually observed and set down, but as a general rule no further use is made of the needle. All government surveys are now required to be independent of the use of the needle, except so far as to find from these star or sun observations the amount of variation, and report the average of each township. Hence it is no longer a reputable proceeding for a surveyor to enter on a piece of work with a scientific calculation of the "variation" supposed to exist when the old lines were run, the rate of annual change, the number of years elapsed, and all the rest of the troubles that used to be thought necessary when it was rare to find a surveyor who had the enterprise to get the true meridian by direct methods. At the office of surveyor general of a certain State, we used to laugh at the frequent letters from distant country surveyors, begging to be informed what the variation was in their region, supposing that "variation" was an official secret, not obtainable by themselves, but something kept on tap at the office and retailed out to favored applicants.

The solar compass, or transit, is mostly used in the surveys and inspections; but its results are not accepted as reliable unless the instrument is proved to be in perfect adjustment and skilfully handled. Such proof can only be obtained from a

confirmatory observation of Polaris, or by transit observation of the sun. The latter method is intricate and laborious, compared to the simple and sure results from the star; hence I have grown more and more into the practice of relying on the latter, as the primary and ultimate test of my courses, only using the solar when more convenient.

By the habit of using a Polaris meridian, and by transit angles preserving connection therewith through one or more days' work, instead of frequent independent solar observations, I am able to work without interruption through the noon hour if I wish, and to continue every day unhindered by clouds or prairie smoke; and this appears to be quite advantageous to the public service in other ways not here specified.

The instructions require us to extend lines so as to make a closed survey around one or more sections, as often as possible, especially where wide discrepancies of course or distance are found in the deputy's work. Thus the office at Washington, by traverse of my closed survey, forms its conclusion as to the accuracy or error of the two discordant sets of field notes. In case chainmen report an excess or shortage in the deputy's line, of unusual extent, say above thirty links in a mile on mountainous surface, or ten to fifteen links on even ground, they are often required to rechain it, to guard against possible error on our part before reporting the error against the deputy surveyor.

For prairie work, a steel tape 400 links in length is very convenient, as it reaches level across many a ravine, timbered gulch, or strip of water, saving chainmen much labor and inaccuracy. Even on smooth prairie there is a decided advantage, suppose ten miles of line were to be run in a day, in having to stoop and set a pin only 200 times instead of 800 times, besides removing 600 chances of error in placing the pin.

But in ascending and descending long slopes, nothing supersedes the patient method of short measures, dropped pins or plumb-line, and careful addition of distance by both men. Slope deductions are wrong unless the slope is uniform, and are not to be trusted, though triangulation often must be resorted to on difficult heights.

It is a very common thing to find the reported length of a line verified by my chainmen to the exact link; but usually

there is some difference. I have averaged the results of a large number of miles, from my field notes, and find that in five or six of the fifteen contracts I inspected this year, having from two to fifteen townships in each contract, the average difference between the deputy's reported distance and our own, over rolling and even hilly prairie, was only from three and one-half to five links to the mile. On several others the average error was from six to eight links ; and on three or four of the least accurate it was about sixteen links, with many lines nearly correct.

As to accuracy of courses, a very close agreement is usually found. The instructions are, to set over some corner, obtain our own true meridian, and run some line from it on the exact course given by the deputy ; record all topography, so that the two sets of independent field notes may test the care and thoroughness of both deputy and examiner ; report the distance on line to a point opposite the quarter corner (if found off my line), also its distance off line ; describe fully the form, condition and marks of said corner and all its accessories, such as post, stone, mound, pits, charred stake, marked memorial stone twelve inches under ground, pits, etc., with the true distance, bearing, size and marks of each witness tree ; proceed in the same way to the section corner, describing it fully ; note the precise angle turned at every change of course, giving true compass courses but not transit angles ; ignore the magnetic needle and its variation, unless we happen to find unusual local attraction, which should be reported ; and verify our courses whenever possible by solar observation, and by closing on our own lines, to show if error or deviation has occurred.

In this work it is not infrequent to run a line of sharp-pointed sight-mounds (erected by the flagman, whose only flag is his spade) over two or three ridges, and find the line intersects the deputy's corner stone ; though it is much more common to find the line pass two, three, or five links from the corner, showing that the limit of error is only one or two minutes of arc, and that the deputy may be the one whose course is exactly right, for such close agreement is not expected between two different parties. Yet in 1897 I examined thirty townships of hilly prairie, in which it was unusual and surprising to find the discrepancy in course as high as five minutes, or the differ-

ence in chaining as much as twelve links. Compare this with the tests of work done with open-sight needle compasses, and two-pole chains, and be thankful that the world moves.

Yet of course once in a while a serious error of fifty or one hundred links is found, which is apt to compel the deputy to make an expensive trip to the field the next year, to correct some irregularity, made against his order by some unfaithful assistant, before his whole contract can be accepted and paid for.

Sometimes it is practicable to find a good camp close to a corner of four townships, so that the requisite seven or eight miles in each township can be inspected without moving camp. In such cases, where the surface was clean rolling prairie, we have now and then completed one township in the forenoon and another before dark. But in Bad Land country no such rapidity is possible.

In the dry, clear climate of the high prairies I have several times succeeded in making a perfect Polaris observation while the sun was shining, even half an hour before sunset. For this purpose the azimuth for elongation must be set off, the telescope elevated to the proper angle according to latitude, the focus adjusted for infinite distance, and the eyepiece muffled in a dark cloth, in which the observer must keep his eye pressed, looking through the aperture, till his eye grows accustomed to the darkness it causes. If then he searches patiently he is often rewarded by the sight of Polaris blinking steadily at him in the gray blue vault, no lantern being needed to show the cross hairs. This is a very gratifying method in October and November, when elongation comes before sunset, and culmination is interfered with by low strata of clouds obscuring Ursa Major.

There may be listeners to these notes who have had reason to know the worthless and negligent practices of deputies in public land surveys of some of the Western States; and who may be surprised at such a report of the excellent work prevalent in South Dakota, even among the Bad Lands and on the Indian reservations. To such I would simply refer to the lasting and beneficial effects that sometimes follow the administration of an able, upright, and energetic public officer; and to

the fact that Cortez Fessenden of Michigan was surveyor general of Dakota Territory less than twenty years ago ; and that his influence and example still survive.

It would double the extent of this paper to dwell upon the rich and varied experiences gained by traveling and camping in the great reservations of the Sioux tribes, as we have been doing from early June till late October. Surrounded by Indians who were usually innocent of any knowledge of English ; visiting Indian schools and missions ; resorting for supplies to the Indian agency and trader's store ; observing the natives' pitiful attempts at agriculture in a drought-cursed region, and their invincible indolence ; studying the strange phenomena of white men with squaw wives and half-breed descendants ; gathering Indian relics and wonderful cretaceous fossils ; photographing objects of scenery and ethnology ; exploring miraculous places in the Bad Lands ; preserving strange insects, lovely flowers, and gay birds ; gathering rare eggs in June, and cooking wild fowl in autumn ; collecting buffalo horns not yet worthless after twenty years of weather ; seeing almost the last of the antelope race ; tracking beaver and inspecting their dams, where State protection bids them recolonize their ancient haunts ; visiting the great stock ranches, and meeting round-up parties at their work ; shooting at big gray wolves ; hearing the marvelous concerts and symphonies of coyotes all around camp,— all these possess interest not allayed by the experience of one season, or even of two.

Yet the dark side of the picture exhibits all the discomforts of heat, fatigue, hunger, thirst, filthy water pools, slow-poisoning alkali water, drought, burnt prairie, spring rains, gumbo mud, high water, dangerous fords, teams strayed and lost, insect pests day and night, privation of war news and home letters, constant risk of life among rattlesnakes, tent-demolishing thunder-storms, scorching sun without shade, furious northwest gales, frost, snow, and bitter wintry cold,— all of which are now become faint memories compared to the worst of all, my narrow escape from succumbing to thirst alone in a waterless wilderness, miles away from my party and the water kegs, in the hot gale of the twenty-seventh of August, 1898.

WITH THE EARLY SURVEYORS OF INDIAN TERRITORY.

O. H. TODD.

ON the twenty-eighth day of June, 1871, a party of ten or twelve men boarded the train of the L. L. & G. R. R. at Lawrence, Kan., bound for Fort Arbuckle, I. T. They were to assist in the general survey and subdivision into quarter sections of the Chickasaw Nation. At the head of the party was Captain R., a man of perhaps thirty-five years of age. He was dressed well, had a long, full beard, and a pronounced military air. He was not hampered by any unusual degree of modesty. He reminded me of the historic "Captain Jinks." Another of the party was Jimmie Brownell, a tall, broad-shouldered young man of twenty-two or twenty-three years of age, of whom I shall have more to say hereafter. Then there was a high-strung, tony young fellow from Hillsdale, Mich. He was well versed in Greek, Latin, and ancient history, and had a saving knowledge of ball-room etiquette. He informed us that he was exceedingly well bred, that he never wore anything but tailor-made clothes, that his father was rich, that he was a graduate of Hillsdale College, had never worked for a living, and expected rapid promotion. Another was a deserter from the regular army, an Irishman, Mike by name. He particularly excelled in jig dancing, profanity, and punishment of poor whisky. "California George" was one of us also. He was a specimen of the better element of that unfortunate class, that legitimate child of our social system, the American tramp; had been in most of the States and Territories, and from unceasingly battling with adversity had lost all interest in life, except the needs of the present hour. Another was Briley. Now Briley was a most remarkable man. He was a native of South Carolina, and claimed direct descent from the chivalry who were the first settlers of the Palmetto State. He had been on board the "Alabama" during her whole career, and having been dumped into the sea at the time of her destruction, was picked up by one of the "Kearsarge's" boats. He afterward served two

years under Custer on the plains. He had a great fund of anecdote, and, taken altogether, was the worst liar I ever met. Ben McLeod was also there. He was born in the highlands of Scotland, came to this country when a child, and had spent most of his life on the frontier. A man of medium height, full and powerful physique, he was fearless, kind, and generous. I never knew him to do an unkind act, or to utter a profane or unkind word. He was one of nature's own noblemen. One more was a boy scarcely sixteen years old; Frank Barnes was his name. He was green, awkward, and slab-sided, was the butt of all our jokes, and a veritable tenderfoot; but long before our job was over, we came to know him as a man utterly devoid of fear, and the embodiment of truth and honor. In fact, he was finally acknowledged to be the whitest man in the gang. Others there were, and among them the writer.

But let us pursue our journey. At New Chicago, now called Chanute, we transferred to the M. K. & T. R. R., which landed us, on the afternoon of the next day, at Pryor Creek station, about twenty miles south of the north boundary of Indian Territory, and the southern terminus of the railroad.

The town of Pryor Creek consisted of three box cars loaded with bacon, about five or six thousand railroad ties in piles, two hotels built of poles stuck in the ground, and covered with boughs and branches, a grocery store of the same convenient material, half a dozen bull and mule teams for freight hauling, one hundred and fifty revolvers and bowie knives, one hundred gamblers, thieves, and all-round scoundrels, a motley crowd of half-witted, half-clad, half-baked half-breeds, a few negroes, and perhaps fifteen or twenty white men besides our crowd.

One of the hotels was run by a half-blood Cherokee woman and her temporary husband, a freckle-faced Irishman. For some unexplainable reason the old lady took a fancy to Jimmie and me. She graciously informed us that she had two grown daughters, children of her first husband, a full-blooded Indian. Further, they were very handsome and accomplished, having attended a term of school at the Armstrong Academy in the Chickasaw Nation, and could ride the buckingest broncho in the Territory. She wished her girls to have white husbands, and further averred that she would be willing to set up

her sons-in-law with a hundred head of cattle and fifty bronchos each.

This offer seemed to be a square deal on the face, and flattering in prospect. I said to Jimmie, "Say, would n't it be a red-hot plan to take the young squaws off the old lady's hands, and get hold of that bunch of cattle and horses?"

To my great surprise and consternation, our interesting mother-in-law in prospect flew into a sudden rage, and fairly screamed, "You —— fool, I want you to understand that my gals are not squaws; they are Cherokee ladies. They would n't marry such coyotes as you and your pardner, no quicker than they would drown themselves. Youens git outen this shanty." We got.

As we went back to the tie-pile where we had fixed our sleeping apartments, Jimmie said, "Oll, you are a first-class chump. Just think of what a good thing we missed by you calling those sweet maidens 'squaws.' I advise you to pare down your mouth, and cultivate virtuous discretion." I was forced to admit the propriety of his observations.

On July 2 we started on foot for Fort Arbuckle, two hundred and ten miles to the southwest. We hired our baggage, consisting of grub, blankets, and a few cooking utensils, carried in a freighter's wagon that was going through to Texas. He was to carry our baggage, and any of our number who might give out on the road, for the sum of thirty dollars. Our grub consisted of coffee, flour, crackers, bacon, baking-powder, and dried, or "jerked," venison. We did not cook any dinner the first noon, merely taking a lunch of crackers and jerked meat. About four o'clock a rain storm commenced, and continued most of the time till dark. Near sundown we stopped on a wooded creek for the night. Some one had to cook the supper, and it at once developed that there was not a man of our crowd who felt competent to undertake the job. Finally Briley, the ex-pirate of the "Alabama," agreed to do the best he could as cook. But the rain continued, and it seemed as if we could never start a fire. At last we succeeded. It was more than two hours after sundown, when supper, consisting of coffee, bacon, and "sinkers," was announced. Just at this stage of the game an old sow and litter of half-grown

pigs, that had been hiding in the brush near by, made a rush for our grub pile, tipped over and spilled the coffee, grabbed the "sinkers," or biscuit, actually yanked the "sow-belly," or bacon, out of the skillet, and skinned out in less time than it takes to tell it. Our supper had vanished, and evidently we had lost the trick.

"Then methought the air grew denser," and had a sulphurous odor. Groans almost unutterable, freely mixed with axiomatic expressions of unusual force but questionable grammar. The only German with us broke forth in one of the grandest poems (blank verse) of the Fatherland, consisting entirely of first-class Dutch cuss-words. His kind thoughtfulness quite won our hearts, and was a grateful relief to those who could not command words adequate to the occasion. Then the rain came down in drenching sheets, and as it was impossible to kindle more fire that night, we made the best supper we could out of crackers and venison.

The wagon was loaded for the most part with flour in cloth sacks, and had, of course, a canvas wagon-cover. I lay down on the flour sacks and tried to sleep, but this was impossible; and when the sun, glorious and beautiful, arose over the eastern prairies, I crawled out of that wagon with a desperate determination to have a square meal or perish. To my delight, every man of the company was possessed of the same idea. We hustled up some dry wood, placed a guard around the fire to keep the hogs away, cooked a large quantity of coffee, meat, and sinkers, and then proceeded to satisfy our hunger. It is needless to remark that we did not eat any dinner that day, and in fact were not very hungry when supper time came.

The weather was pleasant during most of the remainder of our journey. On July 4 we crossed the Arkansas River at the mouth of the Grand, about four miles west of Fort Gibson. We were now in the Creek Nation, and on July 6, passed through its capital, Okmulgee. A big pow-wow had been held here a day or two before our arrival, and a thousand or more braves from the Comanche, Kiowa, Cheyenne, and Arapahoe tribes were camped near the town. They were in full dress, consisting of an abundance of grease, paint, and dirt, plenty of brass jewelry, and very little clothing. In fact some of them

seemed clad only in modesty, and that of a poor quality. They were, however, proud, dignified, and reserved, with the exception that they were eternally begging for "chemuck" (tobacco) and whisky.

The Creek country was alive with game, bear, deer, panther, and wildcat being abundant; as were also the rattlesnake, blacksnake, and moccasin, the centipede, scorpion, and tarantula, much to our annoyance and danger. Along the trail we followed grew the largest and sweetest blackberries I ever tasted, being much superior to any raised in California or the Northern States.

There was then considerable fine timber in the Creek Nation and the eastern part of the Chickasaw Nation, but doubtless much of this has disappeared since the advent of the railroad.

We arrived at Fort Arbuckle July 12, having been ten days on the trail since leaving the railroad at Pryor Creek. During this trip of over two hundred miles, each member of our company had demonstrated by his conduct about what kind of a man he was. The glorious captain, he of the military air, had been called down by one of the boys for his overbearing insolence, and, looking into the muzzle of a navy revolver, exhibited by the aforesaid boy, beheld the force of the argument, and without further ado made humble apology. He returned to Kansas without delay, and for aught I know sunk into oblivion.

Jimmie was always the life of the camp. He was a first-class athlete, a splendid singer, jolly and hopeful, a red-hot Methodist of the revival type, never neglected the Bible or prayer, and would unhesitatingly lick any man that dared poke fun at his devotions.

The fine-haired young man from Hillsdale College had completely "petered" on the third day out from Pryor Creek, declared his feet were too lame to walk, and rode in the wagon the rest of the way to Fort Arbuckle. After two days' work on the survey, he broke down entirely, bawled like a calf, was discharged, and sent back to Baxter Springs, Kan., on a bull train. I never heard of him afterward.

Pale, puny Frank Barnes had won our regard by his uncomplaining patience and honesty of character.

Mike, the deserter, had on several occasions demonstrated his capacity to punish the vile whisky that was imported from Texas. On these occasions, Mike, like Tom O'Shanter, was glorious, "o'er all the ills of life victorious." Within a year from the time I first met him he was hung at Fort Smith for a murder committed in one of his drunken sprees.

Briley had entertained us many an hour, as we sat around the evening camp-fire, with weird tales of life aboard the "Alabama," as she sailed o'er the seas, the terror of our merchant marine, till the fatal day when she met the "Kearsarge" and was sent below. One trouble with Briley was that he would always mix in his best yarns some impossible incident that caused all his listeners to have a feeling of being sold. In vain we protested and pleaded with him to leave out the impossible parts of his yarns. He promised to try to accommodate us, but it was of no use; he was a natural liar, and could not control the ruling element of his nature.

The Chickasaw Nation is about a hundred miles square, being bounded on the north by the South Canadian River, on the east by the Choctaw Nation, on the south by the Red River, and on the west by the Apache, Comanche, and Kiowa reservations. Before the war this tribe, or nation, as they style themselves, enjoyed a good degree of prosperity. They had a number of mills for grinding the corn which they successfully raised, had books printed in their own language, several schools, and a form of government somewhat like our State organization. Their chief, or governor, was elected for a term of years by the heads of families, and so also were the members of the tribal council, or legislature. A sheriff and his deputies were supposed to keep order. Many of the Chickasaws owned large herds of horses and cattle, and some of them lived in ease and comparative luxury.

In an evil hour they cast their lot with the Confederacy, and raised a regiment known as the Chickasaw regiment. At the battle of Pea Ridge this force was badly cut up, and in subsequent engagements was nearly annihilated. The various campaigns desolated their fair country, their houses were burned, their cattle fed both friend and foe, and their horses, escaping to the almost impenetrable swamps of the Red and

Wichita Rivers, returned to a wild state, and at that time (1871) roamed in large herds over most of Indian Territory. Cattle and hogs ran wild also, and found rich feed in the dense cane-brakes and forests of the bottom lands.

At Fort Arbuckle, our party, being but recruits, was divided and assigned to the several camps in the field. The survey had been commenced in September of 1870, with headquarters at Fort Arbuckle. Jimmie Brownell and I were detailed to separate camps, he to Richards's camp near the southeast corner of the Nation, and I to Pratt's camp near the Chickasaw capital, Tishamingo. The first day our route lay over the same trail, and that night we camped in a beautiful grove on the banks of the Wichita, about twenty-five miles southeast of Fort Arbuckle. Long into the night, as we lay on the ground beneath the glorious Southern sky, we talked of the past and present, and built grand castles for the future. At last we fell asleep, to be awakened by the mellow notes of the mocking-bird saluting the coming morn. After our breakfast the men joined with Jimmie in devotional exercise. He read from Acts 20 : 36 : "And he kneeled down, and prayed with them all." This incident is indelibly impressed on my memory.

About two hours after sunrise, we came to the forks in the trail, one branch leading to Tishamingo, and the other to Richards's camp on the Red River. Jimmie and I must part. We had been intimate friends for years, he having worked several seasons for me on my father's farm. Never had an unpleasant word passed between us. With best wishes and bright hopes we bade each other adieu. He died in camp of malarial fever on Aug. 3, 1871. "No useless coffin enclosed his breast," but, wrapped in his blankets, he was laid to rest in an Indian burial-ground on the banks of the Red River. In the strength of early manhood, when life was a song, and the future full of promise, he fell a sacrifice on the altar of civilization.

After leaving the wagon and all the men at the forks of the road, I put my bundle of blankets and grub on my back, and started afoot and alone for Harris's ranch on Mill Creek, about twenty miles to the eastward. That day's journey was one of the pleasantest I ever made. Although the sun shone with wonderful brilliancy and power, a cool, western breeze pre-

vented the heat from oppressing. The trail was good, my load was not burdensome, and I jogged along at a fair rate. Herds of sleek deer were almost constantly in sight. Wild turkeys were as plentiful as blackbirds in Michigan. Coyotes crossed my path a number of times, then striking behind me, followed mile after mile, snarling and whining. I stopped for my noon lunch at a clear spring that flowed from the side of a rocky hill. I was provided with a tin coffee-cup and a small skillet. Kindling a fire, I fried a piece of bacon, soaked a biscuit in the bacon grease, stuck the biscuit on a stick, and toasted it before the fire. Noticing some fine wild plums growing near by, I gathered a few, put them in the skillet, and fried them to a nice brown. I think I enjoyed that dinner as well as any I ever tasted. The sauce was excellent; it was hunger. Soon after starting in the afternoon, as I was passing through a narrow belt of timber that skirted a small stream, I saw a large panther crouched on the limb of a tree about two hundred feet from my path. Purely as a matter of discretion, I "left him alone in his glory." A pair of black buffalo wolves followed me an hour or more. They kept thirty or forty rods away and did not seem to care to come nearer. Concealing myself behind a rock at a sharp turn in the trail, they soon came along. I gave the head one a shot from my navy revolver which caused him to jump about four feet high, utter a fearful howl and clear out at full speed. About four o'clock in the afternoon, I arrived at Harris's ranch, where I met a man with a mule team, bound for Pratt's camp at Tishamingo, where we arrived the next day.

The camp was situated on a small island in the swamps bordering the Wichita River. It had formerly been a camp-meeting site, and was shaded by beautiful trees and cleared of underbrush. Logs had been placed on the ground as seats for worshipers, but now were often occupied by the diamond rattler and huge blacksnakes from the swamps. Care and caution were necessary, especially after nightfall, to avoid collision with these reptiles.

I shall never forget the next day after my arrival in camp. I had confidently expected to take a transit or solar compass, but to my great surprise, by a written order from Arbuckle, of which

I was the bearer, I found myself promoted to the position of chainman. I felt that it was a rank injustice that I, who claimed to have a fair education, having not unsuccessfully taught several terms of school and having a letter of recommendation from the county superintendent of schools; I, who was a member of a very aristocratic and exclusive Presbyterian church, was assigned to the chain gang! The action of those in authority seemed to me wickedly absurd, and I was reminded of the anathema in Burns's "Holy Willie's Prayer:" —

"Lord, curse them in basket and their store,
Kail and potatoes."

I could only conclude that it beat the devil.

That day we worked in the bottom lands of the Wichita. We were obliged to wade hip deep in some places through stagnant water, and make our way as best we could through the almost impassable tangles of greenbriar. Each man carried a couple of biscuit and a slice of bacon wrapped up in a canvas cloth and tied to his belt, for his dinner. One man carried a two-quart canteen of water. There were five men in the party: a compassman, two chainmen, a cornerman, and an axman. The sun shone with intense light and heat, and the moist, miasmatic air of the swamps was almost suffocating. At noon we stopped for lunch on a sandy bank of the Wichita. We were all very thirsty, our drinking-water having been exhausted. The water of the Wichita is about the color of yellow ocher, caused by the banks of yellow clay through which it for the most part takes its course. At that time of the year, it was blood warm, and had a very disagreeable taste. Although we drank freely of the vile stuff, it did not seem to allay our thirst. The mosquitoes were in evidence, and seemed determined to eat us up. Lazy alligators, with upper jaw thrown back, floated down the river, occasionally bringing their jaws together with a snap to imprison and swallow the accumulated flies and mosquitos. The banks of the river were fairly alive with diamond rattlesnakes, the most poisonous of their kind. After eating our lunch, and taking a smoke, we started to work again; but the mosquitoes were so numerous and persistent that about two o'clock we started for camp, about five miles distant. The heat

was intense, and we could find no water fit to drink till about four o'clock. Almost crazed from thirst, we reached the great Tishamingo Spring on Pennington Creek, about a mile from our camp. Only those who have experienced terrible thirst can understand what may have been implied by the revelator when he declares, "He showed me a pure river of water of life, clear as crystal."

The Tishamingo Spring is one of a number of great natural fountains that exist between the Arkansas and Red Rivers. It pours forth at the rate of three or four barrels per minute, clear, cool, and sweet, from a fissure in the rocky hills. Tumbling down its rocky path a hundred feet or more, it crosses a great conglomerate rock, and, plunging into Pennington Creek, forms a beautiful pool a chain's length across and eight or ten feet deep, the water so clear that the sand and small pebbles of the bottom are easily seen, and so cool as to be good to drink even in the hottest summer weather.

I found Mr. Pratt, the chief of camp, to be a very agreeable gentleman. He was the son of a clergyman of Green Bay City, Wis., and a graduate of a college. He had served five years in the regular army, and had his right eye shot out by Quantrell's guerrillas at the battle of Baxter Springs. He informed me that it was an invariable rule on the survey that all recruits must take a subordinate position till they had proved by their skill and industry a right to advancement. I felt the justice of this rule, and could perceive that I had no just cause for complaint. Borrowing a book of instructions from Mr. Pratt, I carefully studied the rectangular system of land surveying, the laws and practice relating thereto, and the use and adjustments of the instruments. Applying for examination, I was in a short time appointed compassman.

As the summer heat became more intense, the mercury often indicating 120° in the shade, most of the camps were obliged to suspend work. The hospital at Fort Arbuckle was soon full to overflowing, and strong men withered and fell before the deadly malaria of the swamps. Very little surveying was done during August and September. A haying camp was established on the bottoms of Wichita River and Wild Horse Creek, two or three miles from Fort Arbuckle, and there

all convalescents were sent, after graduating from the hospital. Near the last of September our camp was re-established in the field on the headwaters of Pennington Creek, about fifteen or twenty miles north of Tishamingo. The country in which we located was mostly high, rocky prairie broken by deep wooded ravines, through which flowed small streams of clear, pure water. Many fine springs poured from the hillsides or trickled from rocky crevices. In deep gullies grew fine persimmons, delicious plums, and great fat haws. These fruits were a welcome addition to our somewhat limited bill of fare. Our work was over broken country, and consequently somewhat tedious. Continuing northward, in November we crossed the Arbuckle and Blue River Hills, and camped on the tributaries of the South Canadian. This country was well watered, well timbered, and plentifully supplied with game, deer, bears, and panthers being numerous, with an occasional herd of buffalo. We could generally buy fresh meat of the Indians, but these same Indians would plunder and rob our provision wagons whenever opportunity offered. No Indian seemed to have the courage to neglect to steal or beg all the tobacco, coffee, sugar, or bacon that he could lay his hands on. Right here I wish to say that the average Indian has little in his make-up to commend him to his paleface brother.

The spoken language of the Chickasaws of to-day is an admixture of their original language with considerable Spanish and a little English. It consists of a few root-words with a variety of prefixes and suffixes. For instance, *si*, an affirmative, may mean "yes," or any other form of affirmation; *shō* may mean "no," or any other form of negation, according to circumstances. The root *suba* means "horse," the suffix *shā* stands for "young," or "little." *Sūga* is "hog;" *waka*, "cattle." Then a colt is *subasha*; a pig, *sugasha*; a calf, *wakasha*." Flesh is *nippa*; therefore horse-flesh is *subanippa*; pork, *suganippa*; beef, *wakanippa*. A chimney is *chimborazo*; a briar patch, or thicket, is *bissaloo*; spreading horns, or antlers, *ippish collappa*; a pretty girl, *icta naha*. Their language is soft, musical, and quite expressive. The universal language of signs is, however, used by them in preference to spoken words.

About a week before Christmas we bade adieu to the Chickasaws, and crossing the country of the Creek Nation to the north bank of the North Canadian near Shawneetown, were in what was then known as the Creek and Seminoles ceded lands, now called Oklahoma. This is a very beautiful country. The rich prairie bottom lands were bordered with gently rolling hills covered with a fine growth of oak, pecan, and hickory. These timbered hills gradually became more rugged, the timber scarcer, and at twenty or thirty miles north of the river, were rough and rocky, and the timber thin and stunted. The weather was sometimes rainy and cool, so that for days together we would be wet through, and of course not very happy. The Indians were quite troublesome, stealing our provisions while they were en route from the base of supplies, and on several occasions our rations were very short. At one time we subsisted about a week on roasted acorns, wild artichokes fried, grasshoppers, and delicious beefsteak cut from the ham of an Indian pony that got stuck in the mud. Four men were killed by the Indians, and one, Paul Richards, was lost from camp and nothing was ever seen or heard of him afterward, though we searched more than a week. Our clothing was worn out, and about every man was bareheaded. We adopted the buckskin costume partly from fancy, but mostly from the fact that it was the only available material. After we had worn out our shoes, we made moccasins or went barefooted, as was more convenient.

With us at that time, there were few who could appreciate good grammar; and dogmatic theology was at a discount. But all was not hardship. There was often something to laugh at, and to cheer us. Between Christmas and New Year's we invited the boys of the ranges to the east and west of us to attend a dance given at our camp. They brought their wagons with them and taking apart their wagon boxes and ours, we placed them on the ground for a floor to dance on. A violin, flute, and clarinet supplied the music. A big fire burned convenient to the dancing floor, and with the exception of an hour's recess for supper about midnight, services lasted from dark to daylight.

But all things end, and so did our survey. On Feb. 14, 1872, we reached our northern headquarters, twelve miles south of Arkansas City, Kan., where we were paid off and discharged.

The years roll on into the silent past. My hair is turning gray, but still I love to think of other days, when I was with the early surveyors of Indian Territory.

A SUGGESTION ON IRRIGATION.

A. L. REED.

OUR worthy secretary has placed on the program a paper from A. L. Reed,—“Something on Irrigation,”—and if I do not write it, I do not know who will ; so with the limited time and more limited knowledge at my disposal I will write briefly that you may not be disappointed.

For several years past the American Society of Irrigation Engineers, an organization formed of many of the best engineers of the Western and Pacific States, has been steadily working at the various problems which in the line of irrigation engineering and kindred topics are brought to their attention for consideration. Among the most important of these has been the disposition to be made of the great arid and semiarid plains of the great West, and in connection therewith the storage and conservation of the rainfall in mountain reservoirs, etc. I need not, however, discuss these large problems, as the proceedings of the organization are obtainable by those who choose to go into their discussion ; but I wish rather, as was suggested a year or two ago, to offer some suggestions in relation to the feasibility of irrigation in the central Middle States, where ordinarily the rainfall is sufficient to raise the usual crops.

It appears to me that the conditions that existed in southern California years ago, and the development of irrigation systems that followed there, in a measure obtain in many of the central Western States. They have, of course, a rainfall more equally distributed throughout the year, and as far as the growing season is concerned, the year is practically cut in half, and perhaps the same degree of success might not be secured in Michigan, for instance, as in California. However, I think there are many localities in Michigan, Ohio, Indiana, and many other States where irrigation systems of perhaps somewhat limited extent might, with large profit, be constructed and used.

I presume that there is not a member of this society, who, if he thinks of this matter at all, can not recall some, at least, and possibly a great many, locations where a rich valley of considerable extent lies close alongside a living stream; and where in certain seasons of deficient rainfall crops have been failing for want of sufficient moisture, while within a few rods, or a few hundred feet at farthest, and a very few feet lower than the surface of the land, ran, in a living stream, from a few cubic feet to hundreds of cubic feet per second of pure, life-giving water. Bring to your mind one of these locations, and think how easy it would be to go a few hundred yards, and open a surfaced ditch with a slight fall, and take from the stream a few cubic feet per second of water, convey it to the parched land and drying crops, and distribute it thereon; and as the result of the expenditure of a few dollars, or perhaps a few hundreds at most, secure for the tract of land an unfailing supply of water, and double the value of the land by taking it out of the list of uncertainties, and making it a sure crop producer, rain or no rain.

This is practically what is being done in all countries where irrigation is practiced. Of course the constant use of the water here in California, and the long (nearly all the year round) growing season warrants more expensive and extensive systems than would be practicable in the other case; but even with the short season I am satisfied that especially near cities such work could be carried on very successfully and profitably in the conduct of market gardens and what is called intensive farming. Indeed, irrigation is being practiced already in many places, but it is subirrigation. Lands but a few years ago considered worthless bogs, with water standing in pools the greater part of the year, have been drained, and have become the most valuable of lands. If the drainage ditches make them too dry, all that is necessary is to dam the ditches and raise the sub-water surface as much as is desired. Such places as these are found in southern California. Lands which ten years ago were counted nearly valueless have been drained and cultivated, and now celery by the hundreds of carloads is shipped to the East every winter at a large profit.

As the country becomes more settled, and the demands

upon the lands greater, I am convinced that what I have referred to in the way of irrigation will be done; and that streams which now are useless in this direction will be utilized; and will be made to gladden the land in other ways than by simply running through it.

The suggestion herein made could be carried out without even making a dam on the stream; but were it successful, and large areas found available, as doubtless they would be, there are many streams on which a dam could be built with little expense, and large storage had, if necessary. In fact it appears to me, on giving the matter thought, that the field will become almost limitless, and that the time will come, perhaps not in our day, when very much will be done in this line.

I have not the time, nor you the patience, to hear the subject greatly enlarged upon; but these suggestions may make a topic for further useful discussion if the society is so disposed.

SECOND-GROWTH TIMBER IN NORTHERN MICHIGAN.

J. J. HUBBELL.

It is gratifying to notice the increased interest that is manifested in the subject of forest growth in Michigan. This is encouraging for the limited amount of work that has been done in this line, and because the subject is one that most men look upon as something so slow, and the results so remote, that it is hardly worth while to look into it.

A friend of mine, who was an editor, took for his motto, "Devoted to the interest of the people now on earth," which motto would hardly answer for the subject of forestry, provided that your idea of forestry is to produce a second growth of timber that will compare in age, size, and value with the magnificent growth that is rapidly being lumbered in the State of Michigan; and provided that your idea is to produce another such growth of timber for the same purpose; that is, to continue to feed our voracious sawmills. In such a case, life would be too short and the results not worth our while. But I understand we wish to encourage forest growth because forests serve as a wind-break and shelter from the storms. They shade the ground, and preserve the rainfall and our water-supply; they prevent the leaf mold and humus from drying up and blowing away, and by their foliage add to the fertility of the soil from year to year; they also purify the atmosphere, and add beauty to the landscape; and, as a last result, though not the most important one, they will furnish fuel and building material for the people who inhabit Michigan in the future. For these reasons I think we need to commence the work at once, and if I shall live long enough to see our waste lands covered with a thrifty growth of young trees, though they be no higher than my head, I shall feel satisfied with the progress of the work and the prospective results; for it is said, "A good work well begun is half done."

The necessity of this work in northern Michigan is greater than in the southern part of the State. There, as fast as the

timber was removed, the ground was occupied for agricultural purposes, while in northern Michigan nine tenths of the ground where the timber is removed is practically abandoned, and no attempt made to use the same.

My acquaintance with northern Michigan extends back to the year 1862. At that time we looked upon the magnificent growth of timber as an incumbrance to the land; but we have long since ceased to regard it in that light, and are now wondering what will become of the country after the timber is all removed.

In hopes of adding something to the information at hand for the solution of this problem, I have been engaged for some time past in a study of the second-growth timber that comes under my observation. In two instances I have measured one acre of ground upon territory where the original timber has been removed for a period of thirty years or more, and have tabulated the result which is herewith attached.

The first acre examined was on Sec. 29, T. 22, N. of range 16 W., about six miles from the city of Manistee. I found 69 white pine trees ranging from four to twelve inches in diameter, 31 Norway pine, 13 black oak, 4 white oak, 6 poplar, 2 soft maple, 2 beach—127 in all. Thirty-eight of these were 4 inches in diameter; 33, 5 inches; 25, 6 inches; 8, 7 inches; 10, 8 inches; 6, 9 inches; 2, 10 inches; 3, 11 inches; and 2, 12 inches. The original growth of timber upon this land was white pine and Norway, with an occasional scraggy oak. It was lumbered in the year 1868 in the old-fashioned way, leaving long butts and long tops, all dead stubs and defective timber. Since then it has been entirely neglected. Forest fires have swept over it from time to time, and have had every license to do their worst. The soil is of light sand, and of second quality.

The second acre examined was on Sec. 2, T. 26, N. of range 13 W. in the northeast part of Benzie County. This was strictly second-growth hardwood timber. Upon this acre I found 144 sugar-maple, 205 elm, 15 basswood—364 in all. One hundred and twelve of these trees were 4 inches in diameter; 99, 5 inches; 69, 6 inches; 34, 7 inches; 29, 8 inches; 12, 9 inches; 4, 10 inches; 4, 11 inches; and 1, 12 inches.

The original timber growing on this land consisted of gigantic sugar-maple, elm, and basswood. The land was cleared in the year 1865, designed for a farm, but soon abandoned. The soil is of a good quality of sandy loam. From these lands and others I have selected a number of specimens which I have here before you.

Specimen No. 1.—Cedar cut on Sec. 26, T. 26, N. of R. 15 W. Twenty-six years old, 6 inches in diameter at stump, 24 feet high over all, and had 14 feet of body over 4 inches in diameter.

Original timber growth : cedar, hemlock, and birch. Cut in 1863. Partially cleared, and no fires after first year. Soil : wet sand and muck.

Specimen No. 2.—White oak cut on Sec. 29, T. 22, N. of R. 16 W. Twenty-one years old, $7\frac{1}{2}$ inches in diameter at stump, 25 feet high over all, 12 feet of body over 4 inches in diameter.

Original timber : white and Norway pine, scattering oak. Cut in 1868, and land frequently burned over. Soil : light sand.

Specimen No. 3 (from acre No. 1).—Black oak cut on Sec. 29, T. 22, N. of R. 16 W. Thirty years old, $8\frac{1}{2}$ inches in diameter at stump, 36 feet high over all, with 20 feet of body over 4 inches in diameter.

Original timber : white and Norway pine, with some oak. Cut in 1868, and land frequently burned over. Soil : light sand.

Specimen No. 4 (from acre No. 1).—White pine cut on Sec. 29, T. 22, N. of R. 16 W. Twenty-four years old, $8\frac{1}{2}$ inches in diameter at stump, 33 feet high over all, with 18 feet of body over 4 inches in diameter.

Original timber : white and Norway pine, with some oak. Cut in 1868, and land frequently burned over. Soil : light sand.

Specimen No. 5 (from acre No. 1).—Norway pine cut from Sec. 29, T. 22, N. of R. 16 W. Twenty-seven years old, $9\frac{1}{2}$ inches in diameter at stump, 35 feet high over all, with 20 feet of body over 4 inches in diameter.

Original timber : white and Norway pine. Cut 1868, and land frequently burned over. Soil : light sand.

*Specimen No. 6 (from acre No. 2).—*Sugar maple cut from Sec. 2, T. 26, N. of R. 13 W. Thirty-one years old, 9 inches in diameter at stump, 40 feet high over all, with 20 feet body over 4 inches in diameter.

Original timber: maple, elm, and basswood. Cut in 1865. No bad fires since first clearing. Soil: sandy loam, clay subsoil first quality.

*Specimen No. 7 (from acre No. 2).—*Rock elm cut from Sec. 2, T. 26, N. of R. 13 W. Thirty-three years old, 9 inches in diameter at stump, 38 feet high over all, with 16 feet of body over 4 inches in diameter.

Original timber: maple, elm, and basswood. Cut in 1865. No fires since first clearance. Soil: sandy loam, clay subsoil first quality.

*Specimen No. 8 (from acre No. 2).—*Basswood cut from Sec. 2, T. 26, N. of R. 13 W. Twenty-six years old, 9 inches in diameter at stump, 42 feet high over all, with 28 feet of body over 4 inches in diameter.

Original timber: maple, elm, and basswood. Cut in 1865. No fires since first clearance. Soil: sandy loam, clay subsoil first quality.

*Specimen No. 9.—*Poplar cut from Sec. 26, T. 26, N. of R. 15 W. Twenty-five years old, 10 inches in diameter at stump, 38 feet high over all, and had 25 feet of body over 4 inches in diameter.

Original timber: hemlock, maple, beech, and pine. Cut in 1862. No bad fires since 1863. Soil: light sand, poor and dry.

*Specimen No. 10.—*Basswood cut from Sec. 10, T. 23, N. of R. 13 W. Fifty-five years old, 11 inches in diameter. Height unknown. About the year 1835 a tornado passed over a portion of Manistee County, and left extensive windfalls in its path. These windfalls are now covered with a thrifty growth of timber,—maple, elm, and basswood in some places, and pine, hemlock, and black cherry in other places. This timber is from 10 to 15 inches in diameter, and stands thick upon the ground, much of it being lumbered off, as other lands are in the same vicinity.

These specimens do not demonstrate that timber grows any

faster in northern Michigan than in any other portion of the State, perhaps not so fast; but I think they demonstrate that with reasonable care and protection our northern wilds need not lay waste and barren any great number of years. The care and protection needed may be enumerated briefly as follows:—

1. Place the lands in the hands of the State as timber reserve lands.
2. Use every precaution to guard against forest fires.
3. Assist nature to a proper seeding of the lands.
4. Strict laws regulating the future cutting of second-growth timber from those lands.

The first to be accomplished through retaining all lands that are forfeited to the State for the non-payment of taxes. The second is the greatest problem that we have to deal with. Destructive forest fires, however, are not so serious as formerly, as lumbermen are cutting their lands cleaner, leaving less material for forest fires, and using more care and caution with regard to the same.

The proper seeding of the land is an important part of the work. I have here pictures showing lands that have been cut off about ten years, which are well stocked with thrifty pines, showing that the land was well seeded. Another picture taken from the same chopping shows but little progress in the way of a second growth. It is simply a lack of seed. Either the pines that grew there at the time the timber was cut did not produce seed that year, the mischievous little red squirrel ate it all up, or forest fires destroyed it. You can no more grow trees from nothing than you can grow corn or potatoes or pumpkins without seed.

Here is another picture of a chopping twenty years old, showing a portion of it fairly well seeded, and a picture of another portion of the same chopping comparatively barren. The first acre of land which I examined, contained in all only 127 trees, and but little over one half of the surface of the ground was covered with trees; while the second acre was well seeded, and not only contained 364 trees over four inches in diameter, but as many more that were less than four inches in diameter.

In regard to the last ; that is, laws regulating the cutting of timber : In a former article I said that the original timber of Michigan was doomed,—bought and held for lumbering purposes, and that it would soon disappear. I am not sure but that public sentiment may be aroused soon enough to save and protect a remnant of our original forests, or at least require such reasonable care as shall prepare the way for and encourage the second growth ; and I trust that after holding these lands in reserve for from twenty-five to fifty years, we shall be able to formulate laws that will regulate the future cutting of timber, and provide for the protection and perpetuation of our forest growth.

No. 1.—RECORD OF ONE ACRE OF SECOND-GROWTH TIMBER
ON SEC. 29, T. 22, N. OF R. 16 W., MANISTEE
COUNTY, MICH.

Taken by J. J. Hubbell, January, 1899.

Kind of Timber.	Number and Diameter of Trees.									Total number of trees.
	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.	12 in.	
White Pine.....	14	19	15	7	6	3	1	2	2	69
Norway Pine....	11	5	7	1	3	2	1	1		31
Black Oak.....	4	4	3		1	1				13
White Oak.....	3	1								4
Poplar.....	4	2								6
Soft Maple.....	1	1								2
Beech.....	1	1								2
Totals.....	38	33	25	8	10	6	2	3	2	127

No. 2.—RECORD OF ONE ACRE OF SECOND-GROWTH TIMBER
ON SEC. 2, T. 26, N. of R. 13 W., BENZIE
COUNTY, MICH.

Taken by J. J. Hubbell, January, 1899.

Kind of Timber	Number and Diameter of Trees.									Total number of trees.
	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.	12 in.	
Hard Maple.....	60	46	25	7	5	1				144
Elm.....	50	51	40	25	22	10	3	3	1	205
Basswood.....	2	2	4	2	2	1	1	1		15
Totals.....	112	99	69	34	29	12	4	4	1	364

STREET PAVING IN MICHIGAN.

YOUR Committee on Materials for Street Paving has not deemed it wise to extend its researches over the entire country, for the reason that the subject is being investigated and discussed by every engineering society; and their publications, many of which are among our exchanges, are available to the members of this society.

In order to present data that will be of interest, and not a repetition of that already published, it was thought best to give a summary of the paving work done in Michigan. Accordingly, question blanks were sent early in the winter to every city and town in the State where there are pavements, and to some where there are no pavements. Although the blanks were accompanied with addressed stamped envelopes, only about one half of those sent out were returned. The replies received have been tabulated, and are given herewith. Table No. 1 shows the total number of yards of pavement of each kind in the cities heard from. Table No. 2 shows the number of square yards of each kind laid in 1898, and the cost per square yard of each kind, thickness, and kind of foundation used, etc.

The city of Saginaw laid last year nearly as much asphalt pavement as all the other towns in Michigan combined, the total laid being 98,157 square yards. Saginaw laid 47,536 square yards, Detroit laid 29,072 yards, and Grand Rapids laid 14,197 yards.

Jackson laid this year its first asphalt pavement, the amount being 7,352 square yards.

Owosso has a contract under way for about 10,000 square yards of asphalt pavement, but no report from that city was received, and no details can be given. The cost of asphalt has varied from \$2.07 to \$1.50 per square yard.

The amount of brick laid during the year slightly exceeds the amount of asphalt, the total being 127,932 square yards, and again Saginaw leads with the greatest amount, having laid 41,732 square yards. Detroit repaved 25,019 square yards with brick, and Grand Rapids laid 24,937 square yards. The

cost varied from \$1.30 to \$1.54 per square yard. Seven cities report having laid brick pavements last year. Ann Arbor laid its first brick pavement last year, but as no report has been received regarding it, no details are given.

From the amount laid, one would judge cedar block to be the favorite paving material. It is reported as having been laid in six cities during the last year, the amount being 348,314 square yards, 290,699 of which were laid in Detroit. The cost is stated to be from \$1.02 on concrete, to 55 cents on planks. Port Huron reports as low as 74 cents on six-inch concrete foundation, and Benton Harbor 90 cents per square yard on one-inch boards on one-inch stringers.

It is worthy of note that the effort is being made to provide a solid foundation for pavements. Only four instances are reported where anything but concrete was used; and in one instance, that at Grand Rapids, where cedar blocks were laid on gravel, the pavement was regarded as only temporary. There being no sewer in the street, it was not thought advisable permanently to pave it. The gravel was rolled with a steam roller until loaded wagons could not make a track in the foundation, and good results are expected, when the cost, 60 cents per square yard, is considered.

Six inches of concrete is the thickness commonly used, and is, in the opinion of your committee, none too thick. There are instances, however, where a slight variation in thickness may be allowed; for instance, where the concrete is laid on top of a firm old roadbed, or where, from the nature of the case, heavy traffic can not reach it, as, for instance, a street situated on a hill, with steep grades in all directions, thus limiting the weight of loads that can reach the pavement. For the heaviest traffic, the concrete should be at least eight inches thick, unless, as before stated, the concrete is to be laid on an unusually firm base.

In Detroit, the inspection for asphalt pavements cost $2\frac{1}{2}$ cents per square yard; for brick, 4 cents; and for cedar block, $3\frac{1}{2}$ cents. As no other cities reported on this point, no comparisons are given.

Mr. G. B. Pike, assistant engineer, Kalamazoo, describes a method of carrying brick from the piles by the roadside to the

pavers, whereby he avoids chipping the brick, as is usual when they are dumped from barrows. He uses a board 4 x 28 inches in size, upon the under side of which, and a short distance from each end, are cleats to enable the workmen to grasp the board. The brick are so placed on the carrying board, that, as slipped off for the pavers, they are convenient to handle.

The total amount of paving in the nine cities that gave totals is 6,471,640 square yards, of which Detroit has 4,813,014 square yards, being more than three times the amount in all the others.

In the city of Grand Rapids, last year, five miles of streets were graded, curbed, and graveled, and the gutters paved with brick. Brick gutters on graveled streets have been almost exclusively laid during the past two seasons. Only screened gravel is used. It is put on in layers, sprinkled, and rolled with a steam roller until solid. When completed, the gravel is from ten to twelve inches thick in the center of the roadway, provided the subgrade has been made sufficiently solid; otherwise it is sometimes sixteen inches thick.

Artificial combined curb and gutters were used in connection with the asphalt pavement laid last year, and also with part of that laid two years ago. The results seem to be satisfactory.

Asphalt pavements are so liable to give out first at the gutter line that other material has been used for gutters during the past few years. Two years ago, in Grand Rapids, an artificial stone gutter the thickness of the asphalt and binder was built on top of the concrete foundation. The results, so far, are satisfactory. In Washington, D. C., vitrified brick alone are used for gutters, and other cities are adopting the plan.

In Grand Rapids, last year, in order to provide a better foothold for horses, there was laid on a seven-per-cent. grade, an eight-foot strip of Medina sand-stone block, while the center of the street, to the width of sixteen feet, was paved with asphalt. An artificial stone curb was constructed on one street, but it is too early to report results.

None of the cities in Michigan report having any asphalt block pavement; and, so far as your committee is informed,

none has ever been laid in this State. It is also a kind of pavement but little discussed in paving reports.

While attending the meeting of the American Society of Municipal Improvements in Washington, D. C., last October, attention was called to the asphalt block pavements laid in that city, some of which have been in use eleven years without expense for repairs.

Washington has probably more asphalt pavement, in square yards, than any other city in the world, although Buffalo, N. Y., has the largest mileage. The annual report of the Commissioners of the District of Columbia for 1897 says: "Sheet asphalt and asphalt block continue to be the pavements preferred by the people, and no other kinds were laid during the year. The western portion of the city seems to prefer the sheet asphalt, while the eastern portion expressed itself equally strongly for the other."

The blocks are composed of crushed trap rock, and asphaltic cement, and are four inches wide, twelve inches long, and five inches deep. Where the subsoil is hard, as in Washington, the blocks are laid on a sand cushion, and at right angles to the curb, and thoroughly tamped, after which the pavement is covered with fine, dry sand, which is broomed into the joints.

Asphalt block pavements are much less noisy than brick, and a little more noisy than sheet asphalt pavements. The blocks can be laid by the same labor that can lay brick pavements. The blocks can be taken up and relaid or replaced with new blocks.

Letters were sent to twenty-two cities where asphalt blocks have been laid. The replies received show that in places, due to one cause or another, asphalt blocks are regarded as a failure, and in other places they are considered far ahead of brick. Their use seems to be increasing, and it is safe to say that improvements in their manufacture have been made, as well as in the manufacture of paving brick.

The nearest asphalt block factory is at New Castle, Pa., and the transportation charges put them out of competition with sheet asphalt or brick for Michigan towns. There is talk of locating a factory at either Detroit or Toledo; so that we may have a new paving material entering the Michigan field.

In this connection I quote from a letter received from Mr. W. S. Wilkinson, of Baltimore, Md., describing a test of three asphalt blocks, made of the following materials: One composed of the best limestone, one composed of the best trap-rock, and one composed of conglomerate sand from the Calumet & Hecla copper mine on Lake Superior.

The blocks were placed side by side near the periphery of a ten-foot marble rubbing bed, running thirty revolutions per minute. Each block was weighed, so that block and weights combined weighed forty-five pounds. They were all kept on the rubbing bed forty-five minutes, sand and water being freely and properly supplied all the time. The limestone block was worn away one inch on its 4 x 12 inch face, the trap-rock three-eighths inch, and the conglomerate sand block one-eighth inch. It is proposed to use the conglomerate sand in the factory mentioned above (Detroit or Toledo).

GEO. M. AMES,
WM. APPLETON,
E. W. MUENSCHER,

Com. on Materials for Street Paving.

TABLE NO. 1.

CITY.	SQ. YDS. ASPHALT.	SQ. YDS. BRICK.	SQ. YDS. CEDAR.	TOTALS.
Detroit				4,813,014
Grand Rapids....	96,105	112,902	239,634	448,641
Saginaw				816,860
Jackson.....	7,352	68,655		76,007
Battle Creek.....				34,956
Flint		23,233		23,233
Port Huron.....				210,000
Lansing.....				13,929
Ionia			35,000	35,000

Table 2 is given on the next two pages.

TABLE NO. 2.

CITY.	ASPHALT.			CEDAR BLOCK.			BRICK.		
	Amount	Cost	Foundation	Amount	Cost	Foundation	Amount	Cost	Foundation
1 Detroit (new)	21,070	1.60-2.07	6" Concrete	162,197	0.95-0.98	6" Concrete	25,019	1.33-1.38	6" Concrete
2 " (repaired)...	8,002	1.63-1.99	6" Concrete	128,502	0.98-1.02	6" Concrete	24,937	1.40	6" Concrete
3 Grand Rapids.....	14,197	1.50	4" & 5" Concrete	17,438	0.60	6" Gravel	41,732	1.29	6" Concrete
4 Saginaw	47,536	1.57	6" Concrete	4,013	0.60	1" board on 3" sand	6,315	1.54	6" Concrete
5 Kalamazoo.....							9,857	1.35	6" Concrete
6 Jackson	7,352	1.60	6" Concrete				6,116	1.30	6" Concrete
7 Battle Creek				20,600	0.90	1" board on 1" stringers on sand			
8 Benton Harbor....							13,956	1.27	6" Concrete
9 Flint.....									
10 Port Huron.....				10,164	0.74	6" Concrete			
11 Manistee (repaired).				5,400	0.55	2" plank on sand			
12 Lansing.....									
13 Pontiac.....									
14 Ionia									

TABLE NO. 2.—Continued.

	MEDINA.			MACADAM.			REMARKS.
	Amount	Cost	Foundation	Amount	Cost	Foundation	
1							
2	2,993		6" Concrete				Cost of inspection for cedar block $3\frac{1}{2}$ c. per yard, brick 4c., asphalt 2 $\frac{1}{2}$ c.
3	612						
4							
5							Concrete composed of 1 cement, 2 sand, and 5 stone and gravel equally mixed.
6							
7							
8							
9							
10				10,315	0.33	8" center, 4" at curb	Concrete composed of 1 cement, 1 $\frac{1}{2}$ sand, and 5 gravel. Milwaukee. City has laid 2,000 cubic yards of Sturgeon Bay limestone. Macadam. Work commenced on 37,000 yards pavement stopped by cold weather. No paving in 1898, but expect to lay 25,000 yards brick in 1899. No paving in 1898. All pavements now laid are cedar block.
11							
12							
13							
14							

THE CONSTRUCTION OF A STONE MASONRY HIGH-WAY BRIDGE AT HYDE PARK, DUCHESS CO., NEW YORK.

With a Few Remarks, Historical and Otherwise, on Stone Masonry Bridges.

BY OWEN MORRIS,
Member of the Society.

HISTORICAL.

THE Chinese seem to have known the arch from remote antiquity, and many of the variations in its structure seem to have been familiar with them. A traveler describes the construction of the Chinese arch thus: Each stone, from five to ten feet in length, is cut so as to form a segment of the arch, and in such cases there is no keystone; the curved stones are mortised into long transverse blocks of stone. (Barrows's "China.")

During the last few years several travelers have published accounts and illustrations of the true arch in the construction of bridges of remote antiquity in China, and of spans varying from thirty to fifty-four feet. An account has also been given of a stone bridge of one arch over the river Liffanyi of 600 feet span and 725 rise, authority not authentic. (Edinburgh Encyclopedia.)

Neither the ancient Egyptians, Assyrians, nor Persians appear to have been acquainted with the true arch, although the arched form has been found in all parts of the world.

The useful application of the arch to bridge-building was not known to the ancient Greeks, as when their architecture had reached its greatest perfection, the people of Athens were compelled to either wade or be ferried over the small river Cephissus, for want of a bridge. (Ency. Britannica.)

The oldest authentic account of the construction of the true arch in stone is that of the entrance gates to the city of Khor-sabad, Assyria, which were arched with voussoir arches of stone of spans from twelve to fifteen feet. (About 715 B. C.)

To the Romans must be given the credit of first communicating to the Western world the application of the arch to works of public utility.

The Ponte de Rotto or Senator's bridge, erected by Caius Flavius (127 B. C.), appears to have been the first instance of its application to bridges in Europe.

The largest stone arch yet erected, of which the record is authentic, was over the Adda at Trezzo described as "consisting of a single arch of granite, very well constructed of stone in two courses, the innermost three and one-half feet thick in the direction of the radius, and the outermost nine inches, the



span low water 251 feet." This bridge was destroyed by Carmagnola.

Another very remarkable structure is the Barbaruh bridge over the Senderud, or "River of Life," at Ispahan, Persia. It has 34 arches of 50 feet span, is 2,250 long, 120 feet high, and 156 feet in breadth, including parapets, with covered galleries on both sides, and a roadway 60 feet wide, battlemented and paved throughout. The superstructure is of Moorish design, but authorities say that the bridge arches and piers are several centuries older than the superstructure.

The Rialto bridge, Venice, of one arch, 98 feet span, 24 feet rise, and 72 feet broad, designed and built by Antonio de Ponte in 1560, is very often erroneously stated to have been designed by Michael Angelo; the mistake has arisen from the

misinterpretation of a passage in the works of Vasari. The art of bridge-building in stone seems to have been cultivated in Britain from an early period with success. The oldest structure of this kind there seems to be the Gothic triangular bridge at Croyland, in Lincolnshire, built in 860. This structure stands at the confluence of three creeks, or brooks (Welland, Nyne, and Chatwater); it has three distinct roadways and approaches, formed by three segments of a circle, which, meeting in the middle, compose pointed arches, their abutments standing on the points of an equilateral triangle. Each abutment stands in a different county, one in Lincoln, one in Cam-



bridge, and one in Northampton. (Fig. 7, page 121.) The triune nature of the structure has led some to imagine it was intended as an emblem of the trinity. In boldness of design and simplicity of construction it is surpassed by no bridge in Europe.

The bridge over the Wear at Bishop Auckland, Britain, built in 1388, is supposed to be the earliest example of a *segmental arch bridge*. It has one span of 100.42 feet and a rise of 22 feet and another of 91.42 feet with a rise of 20 feet.

The first *circular arch oblique* bridge in stone appears to be the one built by Nicoli over the Nugnone near Porta Sangallo at Florence, Italy. Several old examples of the oblique arch are to be seen at Cordova, Spain.

The first *elliptical arch oblique* bridge (built in 1760) is that at Trilport-on-the-Main. The center arch is 81 feet, and the end ones 76, 75 feet span.

The oldest existing stone bridge in Europe is a rude stone beam or lintel. (Fig. 10, page 122.) This bridge is over the East Dart, near Dartmoor, Britain, supposed to be 2,500 years old (is known to be fully 2,000 years old), and coeval with Stonehenge, the famous temple of the Druids. The piers are formed of large granite blocks, and each of the granite slabs forming the roadway is about 15 feet long and 6 feet wide.

The *highest masonry arch* in the world is the aqueduct of Spoleto, in central Italy (built in 741 A. D.); its height from top of water to the parapets being 426 feet, and span 70 feet.



The longest stone bridge in Britain is the one over the Trent at Burton. It is 1,550 feet in length, has 36 arches, and was built in 1146 by the fraternity known as the "Brethren of the Bridge," a society originally formed by monks in France for the purpose of building bridges.

The stone bridges in Europe are numerous and beautiful, but space will not allow me to describe them further.

There is, however, one bridge, which, as a monument of the patience, industry, and talent of its remarkable engineer, I can not pass over in silence. This bridge is probably the most extraordinary of any in Britain. It is thrown over the River Taff at Pontypridd, Glamorganshire, and was erected by Will-

iam Edwards, an uneducated mason of that county, who acquired the principles of masonry by rambling through the ruins of a Gothic castle in his native parish. It was built in 1750 after the failure of two structures which he had previously erected at the same place. The first, of three arches (built in 1746), was carried away by a great flood after standing two and a half years, and the second (built in 1749), of one arch, 140 feet span, failed in consequence of the false-work being removed before the parapets were erected or the ground filled in behind the abutments, the weight of the haunches



forcing out the keystone. The present structure (Fig. 9, page 122), which is still in perfect condition, consists of a single arch with a span of 140 feet and a rise of 35 feet. The outer or showing arch stones are 2.5 feet deep, and that depth is made up of two stones. The inner arch stones are but 1.5 feet deep, and from 6 to 9 inches in thickness, quarried with tolerably fair beds, with little or no dressing in addition, set in mortar made from Aberthaw lime, which makes one of the best natural cements in use even to-day. This important fact has not been noticed by most of the authorities who have written about this bridge, Trautwine included.

Edward's performance gave, as it were, a new impulse to bridge-building in Europe. He built several other bridges, and

improved his work each time, forming his arches of segments of much larger circles, and was in fact the first builder of a *really flat* segmental arch in Europe.

The largest span masonry arch built of sandstone is that built by Messrs. F. L. Hoge and A. L. White, at Wheeling, W. Va., in 1892. (Fig. 11, page 123.)

TABLE OF SOME STONE MASONRY ARCH BRIDGES.

Where there is more than one arch, the span refers to the largest one in the bridge.

	C., Circular. E., Elliptic.	Number of Arches.	Span in feet.	Rise in feet.	Breadth including parapets in feet.	Depth of Actual Keystone.	Date of Construction.	Engineer.
Adda, Italy.....	C	1	251		26	4.50	1377	Duke of Milan.
Cabin John, Washington.	C	1	220	57.3	32	4.16	1859	Meigs.
Grosvenor, Chester, Britain	C	1	200	42	33	4.00	1821	Hartley.
Vielle, Brioude, Allier, France.....	C	1	183	70	16	5.00	1455	Grenier.
Ballockmyle, Glasgow, Britain.....	C		180	58	34.4	5.00		
Jaramze, Austria.....	C	1	213	59			1892	
London Bridge, Britain...	E	5	152	29.5	56	4.75	1831	Rennie.
Wheeling, W. Va.....	C	1	159	28.4			1892	
Gloucester, Britain.....	E	1	150	35	35	4.50		Telford.
Dora Riparia, Italy.....	C	1	148	18		4.92		Mosca.
Pontypridd, Britain.....	C	1	140	35	15	1.50	1750	Edwards.
Den Bunn, Britain.....	C	1	130	29	43	4.25	1806	Telford.
Seine, Neuilly, France....	C	5	128	32	48	5.25	1773	Perronet.
Waterloo, London, Britain	C	9	120	32	48	5.00	1815	Rennie.
Loire, Orleans, France....	C	19	106	30	49	4.60	1760	Hupeau.
Dean Turnpike, Britain...	C	—	90	30	33	3.00		Telford.
Pons Milvius, Italy.....	C	7	80	29	28	4.50	100	Scaurus.
Falls Bridge, Phila. R. R.							B. C.	
Pa.....	C	—	78	25	34	3.00		
Hyde Park, New York....	C	1	70	7	28	3.00	1898	Morris.
Chestnut St., Phila., Pa...	C	—	60	18	—	2.50		Kneass.
Monocacy, Ohio Canal....	E	1	54	9	—	2.50		Fisk.
Senderud, Ispahan; Persia.	C	34	50	25	156	3.00		Barbaruh.
Phila. & Reading R. R. Pa.	C		44	8		2.50	1882	Steele.

HYDE PARK HIGHWAY AND OTHER BRIDGES.

The writer in 1897 superintended the construction of the two bridges shown in Figs. 4, 5, and 6, erected on the private

estate of Frederick W. Vanderbilt, at Hyde Park-on-Hudson, New York.

The masonry structure shown in Fig. 4, with natural surroundings, was faced with unhewn field stone and boulders. It consists of two spans of 53 feet and 26 feet in the clear, respectively. Each has a concrete arch ring, with a rise of 7.5 feet, and is 17 feet wide.

The bridge shown in Figs. 5 and 6, in another part of the grounds, is built entirely of Portland cement concrete, and was given more elaborate architectural treatment. It has a span of 75 feet, with a rise of 14 feet 8 inches, and is 20 feet wide.



This bridge is said to be the best example of concrete construction in this country.

The New York and Albany post road, after leaving the picturesque village of Hyde Park, seven miles north of Poughkeepsie, passes through the estate of Frederick W. Vanderbilt, crossing a ravine through which flows the Crum Elbow Creek, half a mile north of Hyde Park, shown in Fig. 1, page 114. The wooden bridge, with old dry rubble stone piers, early in 1898 had got into such a dangerous condition that a town board meeting was called to consider what was best to be done. The board desired to build a one-arch masonry bridge, in view of its practically everlasting life, nominal cost of maintenance, and that it would harmonize best with the natural surroundings; but grave doubts were expressed whether the dry rubble stone dam (which

impounded a reservoir, the water from which was used for electric light and power and water-supply on the estate), shown in Figs. 1 and 2, would stand the pressure after removing the stone piers of the old bridge, which supported it to some extent. After considerable discussion, the board meeting adjourned without coming to any definite decision. At this stage of the proceedings, Mr. Vanderbilt commissioned the writer to prepare plans, specifications, and estimates for the bridge, the estimated cost of the work being \$10,800. (The parapet walls for 135 feet north, and 146 feet south of the bridge, and not included in the specifications or shown on the plans, were,



after the completion of the bridge, let in a separate contract for \$1,800, and is not included in the present article.) It was understood that the contractor would be allowed to re-use in the new bridge the best of the stone taken out of the old bridge piers and retaining walls (see Figs. 1 and 2, pages 114 and 115), this amounting to 700 cubic yards.

A town-board meeting was again called, and Mr. Vanderbilt offered to pay the cost of rebuilding the parapet walls (\$1,800), and also to pay three fourths of the cost of building the bridge (\$8,100), if the town would pay the other one fourth (\$2,700). This was unanimously agreed to, and ratified afterward by the voters.

A masonry structure was therefore designed to consist as shown in the accompanying illustrations, marked sheets 1, 2, and 3, on pages 125, 126, and 127, which are reduced copies of

the original plans, of one stone masonry arch, 70 feet span, 7 feet rise, and 28 feet wide, with vertical retaining walls about 135 feet long and 36 feet maximum depth north of the arch, and 145 feet long and 18 feet maximum depth south of the arch.

The works were commenced June 8, 1898, and Fig. 3 (page 116) shows the old wooden bridge removed and the temporary bridge constructed east of the proposed new bridge for the accommodation of the traffic.



FIG. 7 - CROYLAND BRIDGE.

Very little excavation was necessary to get to bed rock for the foundation. The rock was "blasted" on the surface, so as to form good "key" for the concrete. The surface of the rock in the bed of the creek was slightly leveled where necessary, to receive the sills, upon which rested the lower ends of the vertical posts of the false-work, which was secured by horizontal crosspieces and vertical X-bracing of eight-inch plank, spiked at every longitudinal and transverse panel. The tops of the posts were sawed off level a little below the springing line, and capped with continuous 6 x 6-inch pieces laid across their tops from side to side of the span. These four lines of top pieces formed sills on which the centering for the segmental arch was supported on pairs of wedges under the vertical posts.

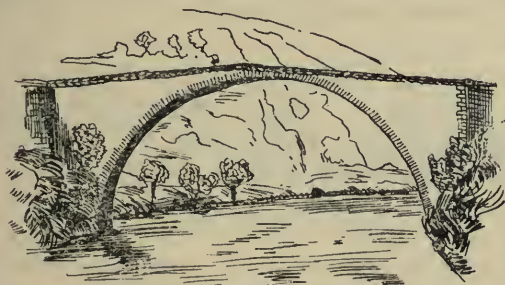


FIG. 8 - BRIDGE OF BRIDGE.

This centering consisted merely of thirteen lines of ordinary curved ribs, made of short sections of double plank, supported on horizontal cross beams at every

joint. Half of these beams were in the planes of the false-work bents, and were supported by verticals over the tops of their posts. The intermediate beams were each supported by pairs of balanced inclined braces running to the feet of the

vertical pieces, and concentrating all the loads symmetrically there above the adjustment wedges. Each set of vertical and inclined pieces was also X-braced with 6 x 1½-inch plank well spiked, and the end half panels were supported by the can-



FIG. 9. PONT-Y-PRYDD.

tilever ends of 6 x 10-inch horizontal chord timbers, which received the lower ends of the verticals and braces. Narrow two-inch lagging was laid on the top of the false-work ribs to conform to the intrados of the arch.

Side walls and coping were built of quarry-faced coursed stone with horizontal beds laid in cement mortar. Rolled earth was filled over the haunches and between the side retaining walls up to the subgrade, and the Telford roadway surface constructed on it, eighteen inches above the crown of the arch.

The whole of the work was carried out strictly in accordance with the accompanying specifications, and under the personal supervision of the writer. Although this arch is, I believe, the flattest segmental arch built of rubble stone masonry on the American continent, such care



FIG. 10. DARTMOOR BRIDGE.

was taken in building the abutments and arch that one week after removing the false-work the total deflection of the arch

was only three eighths of an inch, and no further settlement has taken place, and not the slightest crack of a mortar joint can be detected in any part of the work.

The centering or false-work was made one inch higher in the center than the finished arch was intended to be, to allow for the compression or settling of the false-work under the weight of the masonry, and also for the settlement of the arch after removal of the false-work. By the time the voussoir sheeting of the whole arch was in place, and *before the liquid mortar had been poured into the joints*, the false-work had settled one quarter of an inch, and there was no further settlement.

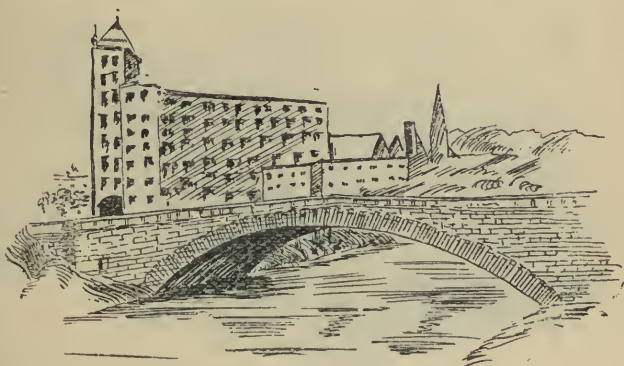


FIG. 11 - MAIN STREET, WHEELING, W. VA.

When the filling in over the arch and roadway was completed to subgrade (just five weeks after the completion of the arch), the operation of removing the false-work or centering commenced, vertical lines at equal distances were drawn on the long sides of the wedges as a guide for lowering them all to the same extent at a time, which did not exceed half an inch per day, in intervals of about one quarter of an inch, and at the end of the third day the false-work was entirely removed.

The Crum Elbow Creek flows through a deep vale that is more than usually woody and hemmed in with hills, and a large number of brooks of no mean capacity that run through deep valleys fall into it. The descents into these vales from the hills being in general very steep, the water during long and heavy rains collects into these brooks with great rapidity and

force, raising floods such as the residents of open and flat districts can scarcely have a notion of, so that the false-work needed more than ordinary care in its construction. Advantage was taken to use the old stone piers as supports for the centering, as shown in illustration on page 125. The 30-inch flume pipe seen at the right of the illustration carries the water from the reservoir on the east side of the bridge to the power-house for electric light and power purposes.

Masonry Arch.—In the construction of the arch, the cut-stone voussoirs forming the end rings, including their key-stones, were set first in the vertical planes of the faces of the

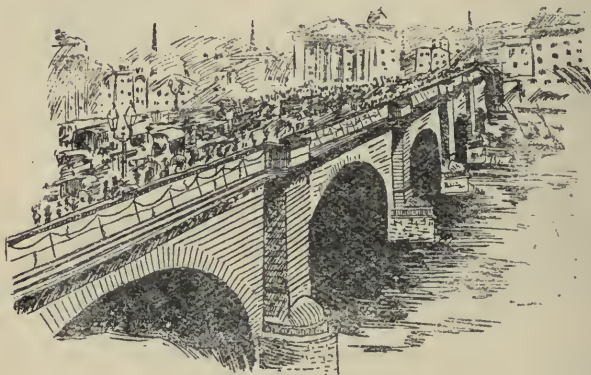
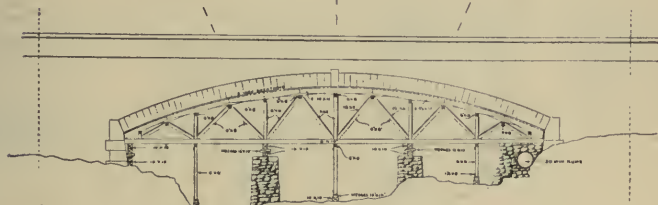
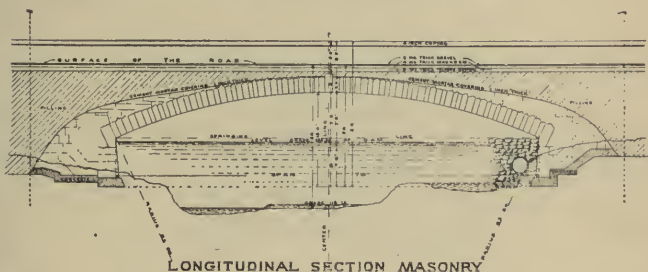


FIG. 125. LONDON BRIDGE
ON THAMES

arch ; the first five courses of the voussoir sheeting from the springing or skewbacks were then set in place across the arch, and to prevent any displacement of the timber false-work, the three courses at the crown of the arch (the keystone and one course on each side) were next set in place.

The interior voussoir sheeting quarried from local sandstone with tolerably fair beds, and in thickness varying from nine to eighteen inches, but of the full depth of the arch and roughly dressed to the radius of the arch, were next laid in continuous courses across the arch, care being taken to have every fourth or fifth course come even with the joint in the stone voussoirs forming the end rings.

The illustration on page 125 will show that *in the design* the principle of the arch is carried out in the abutments, the



HIGHWAY BRIDGE
— OVER THE —
CRUM ELBOW CREEK

— F. W. VANDERBILT, Esq. —
— and the —
TOWN OF HYDE PARK.

CAVE. GFT - 1 INCH.
NOV 1922

DUCHESS CO.

NEW YORK.

OWEN MORRIS C.E.

courses of which are made to radiate toward the center of the intrados of the bridge until they meet the rock in which a step was cut, the bed of which partook of the same slope, so that the rock itself may be regarded as the actual abutment of the bridge.

Masonry Bridges.—On a main highway, masonry bridges are best adapted for the support and conveyance of heavy and continuous traffic, offering advantages not to be had with the

SHEET, NO. 2.



PLAN AND SECTIONS

Showing proposed location of
HIGHWAY & BRIDGE
— over the —
CRUM ELBOW CREEK

for —
F.W. VANDERBILT, Esq. —

AND —
THE TOWN OF HYDE PARK

Dutchess County,

New York.

SCALE, 20 FT.—1 INCH.
MAY 1890

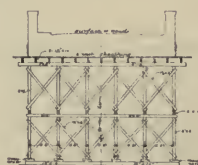
OWEN MORRIS
CIVIL ENGINEER



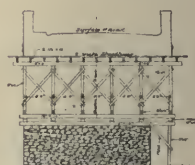
Cross Section — Roadway —



— Cross Section — Completed Arch. —
AT —
E. — F. —



— Cross Section — Frame-work. —
AT —
E. — F. —



Cross Section — Frame-work —
AT —
C. — D. —

SCALE, 20 FT.—1 INCH

less durable iron and steel structures. The maintenance of those stone bridges built several hundred years ago have amounted to almost nothing.

A *Masonry Arch* properly constructed and in a state of equilibrium will maintain its form unaltered as long as the material of the stone endures, and with abutments incapable of yielding, can only fail in consequence of the crushing of its material, the cohesive power of which is the limit of the

strength of the arch. The great advance made in the manufacture of the best Portland cements during the past ten years have made it possible to construct arches of natural stone or concrete of much greater spans than has ever been done before (especially by the use of semi-free or hinged joints at the crown and spring, first advocated by Hartley, England, and illustrated in the 1876 edition of the *Encyclopedia Britannica*).

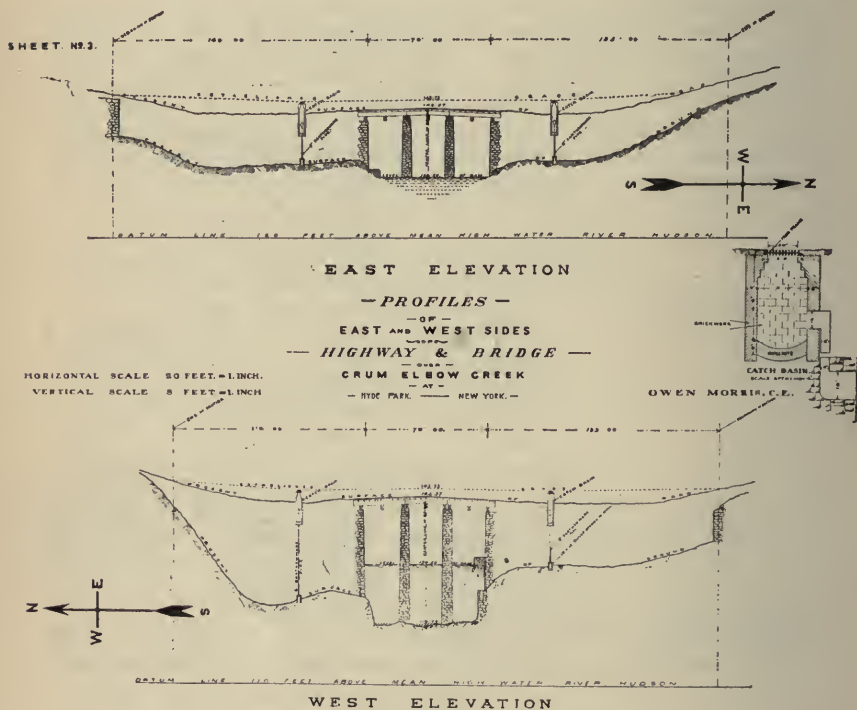
Table showing the relative weights sustained on the crown of each arch by the following bridges in Britain from actual tests. See "Civil Engineering" by Henry Law, *Mem. Inst. Civ. Eng.*; also "Arches, Buttresses, etc.," by A. Bland. The greatest weight which is liable to be drawn over a highway bridge is about twelve tons (say a wagon loaded drawn by four horses, or a traction engine). From this it is apparent that twenty, fifty, or a hundred tons would have no effect toward disturbing the equilibrium of the Hyde Park bridge.

	No. of arches	Width in feet	Span in feet	Weight sustained in tons	Material in arch.	Engineer
Loose, Maidstone	1	28	50	1234	Sandstone	Edwards Sir R. Smirke Rennie
Pont-y-pridd	1	15	140	556	"	
Rochester	4	32	100	3060	Granite	
Waterloo, London	9	52	120	4150	"	
Hyde Park, N. Y.		(Calculated)		1365	Sandstone	Morris

Cement.—During the last ten years I have had, directly or indirectly, to supervise the using of enormous quantities of Portland cement, and have made tests almost continuously of cements from forty-two different manufacturers in the United States, England, Germany, France, and Belgium, and in the case of two English Portlands the tests have invariably shown 12 per cent. greater strength at periods varying from seven days to two years than I have seen recorded for any other cement. Briquettes and blocks of cement and concrete have also been sent under a *number* to three renowned testing establishments in Europe, the cement manufacturers being known only to myself. The recorded tests show that by the careful selection of proper aggregate, such as crushed syenite (hornblende) and good cement, and manipulating this by processes best calculated to secure the most favorable results, including indurating the concrete with a solution of silicate of soda in proper proportions; concrete has been produced that has stood, at one year old, the

enormous crushing strain of *seven hundred tons to the cubic foot*, or nearly double the strength of ordinary natural granite stone, at a cost very little more than that of common concrete.

Owing to German competition (the German manufacturers are assisted by subsidies from the German government), much more attention is now given to fine grinding, and the modern English and American grinding machinery will grind finer and



more easily than any other European machinery. This with the superior quality of the English raw materials and the purity of the manufacture is enabling the English and American manufacturers to recover the ground lost by inattention to fine grinding some years ago.

The Germans secure certain supposed advantages, which are specified for in ignorance of their real nature by some engineers, by an admixture of gypsum in their cement. This

does not secure any real advantage, but promotes slow setting, which ought to be obtained by care in the burning and elimination of all underburnt clinkers. Gypsum imports an element of danger.

There should never be more than three per cent. of magnesia in Portland cement. English raw materials will always produce a cement which is on the safe side as regards magnesia.

HILTON LONDON PORTLAND CEMENT.

The tests here annexed, demonstrate that the Hilton cement justly enjoys the reputation of being one of the best English cements made, which is confirmed by American consumers, who have used it since its introduction.

RESULTS OF TESTS MADE BY LATHBURY & SPACKMAN, PHILADELPHIA.

Tensile strength per square inch, ...	7 days	28 days
Neat, ...	617 lbs.	731 lbs.
3 parts sand, ...	212 lbs.	268 lbs.

The superiority of the Hilton over other English brands is due to its careful composition and thorough calcination, resulting in a uniform Cement of high specific gravity.

RESULTS OF TESTS MADE BY OWEN MORRIS, POUGHKEEPSIE, N. Y.

Tensile strength per square inch, - - -	7 days.	28 days.	56 days.
Neat, - - -	615 lbs.	738 lbs.	829 lbs.
3 parts sand, - - -	225 lbs.	282 lbs.	309 lbs.

RESULTS OF TESTS BY MESSRS. DAVID KIRKALDY AND SON, LONDON, ENGLAND.

Results of experiments to ascertain the resistance to Thrusting Stress of slabs of artificial stone:—

Dimensions.	Base area.	Cracked Slightly.			Crushed, Steelyard Dropped.		
		Stress.	pr. sq. in.	pr. sq. ft.	Stress.	pr. sq. in.	pr. sq. ft.
inches.	sq. in.	lbs.	lbs.	tons.	lbs.	lbs.	tons.
2.06 6.00 x 6.00	36.00	216.100	6.003	386.0	384.160	10.671	686.2
2.06 6.00 x 6.00	36.00	238.800	6.663	426.6	415.220	11.534	741.7
2.09 6.00 x 6.00	36.00	235.100	6.531	420.0	413.870	11.496	739.3
2.09 6.00 x 6.03	36.18	234.400	6.479	416.7	408.200	11.282	725.5
2.08 6.00 x 6.00	36.00	189.400	5.261	338.3	376.380	10.455	672.3

Bedded between pieces of pine $\frac{1}{2}$ inch thick.

Slag Cement.—All slags are not adapted for conversion into cement, as some contain substances which would prove injurious to cement, or do not contain the necessary ingredients in proper proportions. A suitable slag may contain about 37 per cent. of lime, 27 per cent. of silicate, and 20 per cent. of alumina and iron oxide and small quantities of other undefined ingredients. If to this slag 28 per cent. of slaked fat lime were added, we should have a mixture which is actually the approximate composition of one slag cement. Sometimes the slag contains an excessive amount of sulphur, and the cement made from it is of a dangerous quality. A manufacturer's sample of slag cement tested at the Royal Testing establishment at Berlin, was as follows :

Tensile strength of slag cement in pounds per square inch.

Cement neat at 7 days 647 pounds, at 28 days 692 pounds.

Cement and sand (1 to 3) at 7 days 427 pounds, at 28 days 5,091 pounds.

It must not, however, be imagined that all slag cements give equally good results. It has been very largely used in the construction of harbors and other works in the sea in Great Britain, notably in the construction of a breakwater and pier about 850 feet long at the Skinningrove Iron Works in Yorkshire. Mr. G. M. Lawford, in a paper on Fireproof Floors, read before the Society of Engineers, England, states that its fire resisting qualities "exceed those of both gypsum and Portland Cement," and for this reason, among others, it is recommended for use for concrete floors and roofs, etc. The whole of the Portland cement used in the construction of the Hyde Park Highway bridge, was a slag cement manufactured by The Knickerbocker Cement Co., of 66 Maiden Lane, New York City.

I have not the slightest doubt that there is a great future for slag cements if manufactured under continual intelligent supervision. Fine grinding is of extreme importance. There should not be more than 10 per cent. residue on a number 75 sieve (5,625 meshes to the square inch). The tensile resistance of the mortar briquettes is found to follow closely the proportion of residue left on the sieve. The smaller the proportion, the stronger is the cement.

POUGHKEEPSIE, N. Y., July 22, 1898.

Mr. O. Morris, C. E.,

Hyde Park, N. Y.,

DEAR SIR : I beg to report the following result of tests of a sample of Knickerbocker Portland Cement, received from Hyde Park a short time since.

The briquettes were made of neat cement, in standard moulds of one square inch section, in sets of three each :—

No. 1, 9 hours in air and 15 hours in water,	broke at 137 lbs.
No. 3, " " " " " " " " " "	" " 155 "
No. 4, 7 days in air	" " 200 "
No. 5, " " " "	" " 219 "
No. 7, 1 day in air, 7 days in water	" " 300 "
No. 8, " " " " " " " "	" " 333 "
No. 11, " " " " " " " "	" " 362 "
No. 13, 1 day in air, 13 days in water	" " 375 "
No. 14, " " " " " " " "	" " 375 "

The briquettes required about four hours to bear one fourth pound weight on one and one-half inch dia. wire ; and about nine hours to bear one pound weight on one twenty-fourth inch dia. wire.

Yours very truly,

CHAS. E. FOWLER,

Supt. of Public Works.

Specification. The relations that engineers and surveyors sustain to both employer and contractor make it necessary, if they wish to be well equipped for their work, that they should have sufficient knowledge of law to guide them in their everyday duties in the ordinary questions, which arise in their practice ; such as the law of eminent domain as applied to engineering structures, the law of riparian rights, law of surveys, etc. As construction contracts are generally prepared by them, and knowing full well the difficulties in the way of compiling satisfactory specifications at short notice, the writer hopes the accompanying specifications may be of service. They are the result of many years' experience on constructive works.

They were used through the work at Hyde Park, and proved satisfactory, and secured the work's being done without serious disagreement. A number of contractors place their main de-

pendence for profit in getting good prices for extras, and therefore try to get as many extras as possible in the work they undertake. The idea has become general among them that engineers do not mean anything by their specifications, and the acceptance of work inferior in every way to that specified is becoming the rule and not the exception, so that the condition which confronts the engineer who insists without fear or favor on having the work done as specified, is truly alarming. I can not help quoting the following extract in full, taken from a paper on the Park St. Bridge, Hartford, Conn., by Mr. Edwin Graves, President of the Conn. Civ. Eng. Association:—

“The engineer designs a structure carefully, proportions each part to do its work, writes a specification to secure the quality of work on which he has figured his design; the work is given to some one who presupposes that the engineer means nothing by his specifications, the work is built accordingly. If the engineer objects, he is called “cranky” and overruled, but if anything fails about the work, the design is at once blamed and the engineer called incompetent and careless. The average lot of the engineer is indeed far from being a bed of roses.”

My experience has been that he is generally called a good deal worse than “cranky,” and if he is at all weak-minded his disposition is likely to be soured, and his self-respect destroyed by slurs which can only be made by the ignorant or the malicious.

In conclusion the writer acknowledges his indebtedness for valuable information to Lieutenant-Colonel Miller, U. S. Engineer, Washington, D. C.; A. L. White, City Engineer, Wheeling, West Virginia, and for making a number of valuable tests of cement briquettes to C. E. Fowler, Superintendent of Public Works, Poughkeepsie, N. Y.

TOWN OF HYDE PARK
DUCHESS COUNTY
STATE OF NEW YORK

CONTRACT

SPECIFICATIONS, BILL OF QUANTITIES, AND
FORM OF TENDER

FOR A

STONE MASONRY HIGHWAY BRIDGE

OVER THE **CRUM ELBOW CREEK** ON THE

NEW YORK AND ALBANY ROAD

and other works in connection therewith.

For

F. W. VANDERBILT, Esq.

MAY, 1898.

It is to be distinctly understood that the right is reserved to decline acceptance of any or all estimates made in response to this invitation.

Proposals must be made out upon the form of tender hereto attached, and must not be detached when sent in.

OWEN MORRIS,
CIVIL ENGINEER AND SURVEYOR
POUGHKEEPSIE AND HYDE PARK, N.Y.

THIS AGREEMENT made and concluded this.....
 day of.....eighteen hundred and ninety-eight, between
 FREDERICK W. VANDERBILT, Esq., by his Superintendent of
 the Hyde Park Estate, Thomas H. Howard, Esq., of the first
 part and.....

 party of the second part,

Witnesseth, That the said party of the second part has
 agreed, and by these presents does agree, with the said party
 of the first part for the consideration hereinafter mentioned, to
 provide the whole of the labor and materials, carriage, tools,
 implements, tackle, legs, cranes, staging, scaffolding, timber
 centering, stone, cement, lime, sand, etc., and all other things
 necessary and requisite for taking down and removing the
 present wood bridge, stone piers, abutments, retaining and
 parapet walls, and roadway retaining and parapet walls and
 all other works in connection therewith, and constructing a
 one-arch stone masonry bridge, abutments, retaining and
 parapet walls, and roadway and road retaining and parapet
 walls and all other works in connection therewith, and without
 hindrance to the traffic over the highway, for which purpose
 the contractor must make provision by erecting a temporary
 bridge, as set forth in the specifications, and to the forms and
 dimensions, and in the position shown on the drawings, and
 in the manner and under the conditions hereafter specified.

SPECIFICATIONS.

General Description.—The contractor is to provide the
 whole of the labor, and materials, carriage, tools, imple-
 ments, tackle, legs, cranes, scaffolding, staging, timber, cen-
 tering, pumps, stone, cement, sand, lime, bricks, and all other
 things requisite for taking down and removing the present
 wooden bridge, stone piers, abutments, retaining walls, parapet
 walls, and all other works in connection therewith, and for con-
 structing a one-arch stone masonry bridge, retaining walls, par-
 apet walls, stone and concrete abutments, highway roads, road
 retaining walls, and all other works in connection therewith, as

set forth in the specifications, and to the forms and dimensions, and in the position shown on the drawings, and in the manner and under the conditions hereafter specified.

Clearing Site.—The contractor shall remove all old stone walls, stone piers, and fences, root out all trees and brushwood, and clear away all mounds, loose earth, ledge, rock, and rubbish within the area to be occupied by the new bridge and contingent works.

Old Materials.—The materials so obtained shall belong to the contractor.

Temporary Bridge.—The contractor must provide a temporary bridge for the maintenance of the vehicular and passenger traffic without hindrance, danger, or delay, during the progress of the work.

Scaffolding.—The contractor will furnish all temporary planking, shoring, sheeting, centering, timber, false-work, and scaffolding necessary to carry on and complete the works contemplated in these specifications without extra charge.

Filling.—The spaces at the back of the retaining walls, abutments, and other masonry and around the same are to be filled with such filling as in the opinion of the engineer is suitable; no garbage or organic matter will be permitted as filling. The filling is to be rammed into place in layers not to exceed one foot in depth, to guarantee against further settlement. All extra filling material required either for bringing the road over the new bridge up to grade level, or for any other purpose must be found by the contractor and provided for in his estimate.

Coffer-dams.—Whenever, in the opinion of the engineer, coffer-dams are required for the proper execution of any work herein contemplated, the contractor shall provide all necessary materials and perform all the labor necessary to construct the same, and when their use is no longer required, they shall be removed by the contractor, and without charge for construction or removal.

Drainage, Sheeting, and Bracing.—The contractor is to keep all the work free from water during its progress at his own expense, and provide any and all sheeting, shoring, and bracing necessary to support the walls of the excavation in a safe condition during the construction of the work, and draw

the sheeting and bracing on completion of the work as directed. When removing the road retaining walls north and south of the bridge, special care must be taken to shore up the roadway in such a manner as not to endanger the traffic.

Excavation and Foundations.— The loose and weathered portion of the rock to be stripped off to the solid for the whole width of the abutment and retaining walls at their bases, and cut into horizontal beds, without blasting. All loose and unsound places that may be caused during the execution of the works shall be excavated, and the foundations kept dry and clear of all obstructions, from whatever cause arising.

Waste.— The excavated waste from the stripping and trenches shall be removed and deposited at such a distance and place as may be indicated by the engineer.

Cements.— The cements to be used for this work will be of two kinds, viz., Messrs. Hilton, Anderson & Company's best London Portland cement, or other manufacture of equal quality, and Natural Rock Cement, approved by the engineer, and will be subject to the following described tests, as a prerequisite to its acceptance for use:—

No cement will be allowed to be used until the samples of it selected for test have been subjected to seven, fourteen, and twenty-eight day tests; to provide for which the contractor will be required to keep on hand at all times a sufficient stock to admit of these tests being made, and must have on hand at the site of the work the whole quantity he expects to use in the first four weeks of his work at least one month before it will be needed for use.

The contractor will be required to provide a well-protected shelter storehouse in the near vicinity of the work, which shall be used for no other purpose than cement storage, and be always kept securely fastened and protected against unauthorized intrusion, or tampering with the cement. It shall, however, be at all times freely open to the inspection and examination of the engineer.

The contractor must furnish to the engineer duplicate original invoices and bills of lading of all cement ordered by him for this work, and shall afford the engineer every facility needed by him in order to check the quantity and weight of

all deliveries, and prove the identity of the cement actually delivered with that called for by the invoices and bills of lading. The contractor will also be required to submit to the engineer, for acceptance and approval, the names of the manufacturers and the "brand" he proposes to order, before placing any orders with them, accompanied by a written declaration by the manufacturer addressed to the engineer, that in filling the order, if given to him, he will furnish cement subject for acceptance to full conformity with all the following tests:—

The engineer will select samples at random from each cargo or invoice lot of cement as ordered; such number of different samples as in number shall not be less than 10 per cent. or more than 20 per cent. of the number of barrels (or of separate bags or packages) of said invoice lot, and the quantity of cement taken for sampling shall be enough to make not less than twenty-five test briquettes.

Any cement which on seven, fourteen, and twenty-eight day tests fails to meet the hereinafter described tests, and is in consequence thereof condemned by the engineer, the entire invoice lot represented by the samples so tested must be immediately removed entirely off the site of the work and its vicinity, and a fresh lot in substitution thereof must instantly be ordered. No claims for detentions or for extra time allowance resulting from cement so condemned, or condemned for any other cause, will be allowed or considered; the responsibility being solely with the contractor to supply such cement as will not be condemned. Cement may be furnished in either barrels or bags, conditioned, however, on its being in good condition when taken out of store for use. Barrels of Portland cement shall contain not less than 386 pounds of pure cement, and barrels of Natural Rock Cement not less than 300 pounds of pure cement.

Tests.—First. The whole lot of cement taken out as samples shall be well and thoroughly mixed, and the mixture so obtained will be assumed as a fair average sample of the entire invoice lot from which it has been taken.

Second. The requirements under test shall be as follows: Portland cement shall be not less than 90 per cent., and Natural Rock not less than 90 per cent. "fine" on a sieve of 14,400 holes per square inch.

Third. The Light Wire Test: Neat cement mixed to the consistency of a stiff plastic paste, and made into flat cakes of two or three inches diameter by one-half inch thick, shall not set so as to sustain without imprint a wire of one-twelfth inch diameter, weighing four ounces, in less than twenty-five minutes.

Fourth. Checking or Cracking Test: Similar cakes to those prepared for the light wire test, but with thin edges; when hard enough shall be immersed in water for at least two days. If they crack along the edges, or become contorted, the cement shall be rejected; and Portland cement so tested shall withstand, without cracking, a temperature of boiling water (212° F.) after twenty-four hours' immersion in cold water.

Fifth. From the sample mixture shall be made not less than twenty-five testing briquettes. In preparing briquettes for test, sufficient cement shall be taken to make one at a time, using only sufficient water to work into a stiff, plastic paste; the water shall be fresh and clean, of a temperature between 60° and 70° F.; the proportion of water to be used varies with the fineness, age, and other conditions of the cement, and the temperature of the air, but approximately it will be, for neat cement, from 20 to 30 per cent. The paste thus made shall be firmly pressed into the molds, but shall not be rammed in, and shall be struck off level, the molds resting on glass, slate, or other non-absorbent slabs; as soon as hard enough, the briquettes shall be taken from the molds, and be kept covered with damp cloths until immersed.

Sixth. Tensile Strength: Tests for tensile strength shall be made on briquettes of standard form, and no record shall be taken of briquettes that break at any other place than that of their smallest section, which shall be exactly one square inch; for one-day tests the briquettes shall remain on the slab for one hour after being removed from the molds, and then immersed for twenty-three hours in water; for all other tests, the briquettes shall have a set of twenty-four hours in air and the balance of the time in water; the water shall be kept at a temperature of 50° to 70° F., and that of the testing room shall not be allowed to fall below 45° F. The breaking tests shall be made immediately after being taken from the water, and

the stress shall be applied at a uniform rate, starting from zero, of about 400 pounds per minute.

The average tensile strength per square inch shall be not less than the following:—

	Portland Cement.	Natural Rock.
5 Briquettes for 3 day tests.....	250 pounds.	60 pounds
5 " " 7 " 	450 "	75 "
5 " " 14 " 	500 "	90 "
5 " " 21 " 	560 "	140 "
5 " " 28 " 	600 "	190 "
25 Briquettes. Total average,.....	472 pounds.	111 pounds.

Seventh. The right will be reserved to the engineer to reject any cement at any time it may be proved, by subsequent tests for longer period, that the test samples so tested show a diminution in strength or give decided evidence of "cracking."

No German or Belgium cement adulterated with sulphate of lime will be allowed to be used.

 It must be distinctly understood that the above specification will be strictly enforced in every particular.

Sand.—The whole of the sand used in the works is to be clean and sharp, not overcoarse, and to be well washed before use.

Portland Cement Mortar.—The Portland Cement Mortar for the stone masonry in the abutments and walls is to be composed of one part by measure of cement to two parts by measure of sand, and for the whole of the arch masonry one part by measure of cement to one and a half sand, to be thoroughly well mixed before applying the water, and each quantity of mortar made is to be brought to the same consistency as that previously used, sufficient only being made for the immediate requirements; all mortar showing signs of setting to be rejected.

Concrete.—The cement concrete used for filling in the trench in the foundations, and for backing for the masonry in the abutments, and for backing for the haunches of the arch, shall be composed of one part by measure of Portland cement to two parts by measure of sand, and four parts by measure of hard sharp stone, or brick clinkers, the sand and cement to be thoroughly well mixed before the water is added. The stone

or brick clinker is to be perfectly free from sand or dirt and not larger than two inches cube, or smaller than one inch cube; to be well-wetted before being mixed with the cement mortar, and the whole aggregate to be well turned over twice dry and twice wet to insure perfect incorporation, by shovels, upon a specially close-jointed timber floor of ample area and conveniently near the site of the works.

The concrete is to be laid in carefully in horizontal layers of one foot in thickness, to be afterward rammed with wooden or iron rams until a film of water appears on the surface, but not to make it quake.

Measuring Vessels.— Proper measuring vessels are to be provided and constantly used by the contractor in measuring the materials for cement mortar and concrete.

No concrete or mortar is to be worked up the second time after partial setting, nor to be applied to a dry surface. Any portion that is left for a few days is, before placing more concrete upon it, to have its surface well swept, picked, and cleaned, so that a perfectly water-tight joint may be made.

The contractor will be obliged to remove and replace all concrete which in the opinion of the engineer has been injured by frost, heat, or any other cause.

Masonry Construction.— The spandril walls, retaining walls, and abutments of bridge, and the road retaining walls north and south of the bridge, and the up-stream and down-stream sides of all the retaining walls, are to be constructed of uncoursed random rubble, with beds and joints roughly dressed, and projections knocked off, anything approaching regular horizontal joints to be carefully avoided, pains being taken to preserve a good bond throughout the whole breadth and length of the work; the whole to be carried up as much as possible of a uniform height, and in no case is there to be a greater difference of the levels in any parts of the same building than eighteen inches.

All the building stones used are to be placed on their natural bed, and in the abutments none are to be of less size than two cubic feet, and no stone shall be less than nine inches thick, nor less in width than they are in depth of course, all weak corners being knocked off before placing in position,

every stone to be laid full in mortar, and driven home with a light mallet, all spaces between it and the adjacent stone to be filled flush with mortar, care being taken that the mortar and stone do not dry before setting the corresponding range, or that any dry work or hollow spaces occur in the work.

The stones of one range must break joints at least six inches with those of the range underneath. No stone shall be cut on the wall, and no stone once bedded shall be removed unless directed. The face joints of all the parapet walls, retaining walls, and spandril walls, and abutments of bridge on the up-stream and down-stream sides, are when laid in mortar to be left with a one-inch depth, so as to correspond in appearance with the uncoursed random dry rubble walls in the neighborhood of the works with which connection has to be made.

Random, Level, and Broken Ashlar Masonry.—The faces next to roadway of all the parapet walls, are to be built with stone of good quality, and to correspond with the existing random, level, and broken ashlar masonry walls, to which they are to be connected north and south of the proposed new works. Each stone shall be laid in the work so as to form a one-quarter inch joint, and the face of each stone to be rough “bushed.”

Drainage of Masonry.—The road, retaining walls, and abutments, are to be thoroughly drained, and drains and weep holes shall be made where directed, to allow the water to drain off.

Springing Lines and Angles.—Selected stone shall be used at the springing lines of arch for skewbacks and at all quoins and angles, and shall be neatly dressed to the true lines, and laid on dressed beds.

Extrados Ring Stones of Arch.—Ring stones shall be dressed to the size and shape shown on the plans, or as directed by the engineer shall be laid with one-quarter inch joints, and shall bond thoroughly with the sheeting. The joints shall be on truly radial lines. Faces shall be left rough and with one and one-half inch chiseled draft line on the curved margin.

Sheeting of Arch.—Sheeting for arch shall consist of large-sized stone, with radial beds and joints extending through the whole thickness of the arch, and hammer or point dressed so

as to admit of three-eighths-of-an-inch joints. The sheeting shall be laid in continuous courses, care being taken to break joints not less than nine inches, so that the arch will be thoroughly bonded. No stone shall be less than nine inches wide on the intrados.

The ring stones and sheeting stones of arch during construction shall be temporarily kept apart the proper distance, by wedges, and no cement mortar shall be placed between them before the whole arch has been completed, and the position of the arch stones carefully examined; a moderately liquid cement composed of equal parts of clean sand and cement will then be poured into the joints.

Timber False-work.—Centering and false-work shall not be removed until so ordered by the engineer.

Coating on Top of Arch, etc.—The top of the masonry spandril backing and arch shall have a coat at least one inch thick of cement mortar.

Coping Stone.—Coping stone shall be neatly squared not less than four feet long, and exactly four inches thick and twenty-five inches wide, and of the same kind now laid on walls on the southwest side of present bridge. Joints of coping stones shall not exceed one-quarter inch wide.

Lines and Levels.—Whenever necessary, points for the location and proper heights of the structures will be given by the engineer, and such points, pegs, or grade stakes shall be carefully protected and followed during the progress of the work. Where doubt exists as to the correctness of a stake or point, it must be reported to the engineer, and must be tested before proceeding with the work.

Water.—All water used on the works shall be fresh and clean, free from earth, dirt, or sewage.

Natural Rock Mortar.—The Natural Rock Cement Mortar is to be composed of one part by measure of cement to two parts by measure of sand.

GENERAL CONDITIONS.

Drawings.—Wherever the dimensions are marked on the plans and sections, or described in the specification, such dimensions are to be considered as correct, although not exactly

corresponding with the measurement from the scales, which must be referred to only when the dimensions are not so marked or described. The drawings to larger scales, and those showing particular parts of the work, must be taken as more correct than those to smaller scales, or for more general purposes.

Custody of Drawings.—The drawings referred to in the specification, and signed by the contractor, shall remain in the custody of the engineer during the progress of the works, the contractor being allowed access to them at all reasonable times, for the purpose of taking copies of the whole or any portion of them he may require.

Detail Plans.—Additional details and working plans and diagrams will be furnished from time to time by the engineer as they may become necessary for the purpose of more exactly exhibiting and exemplifying the precise manner in which the said general plans are to be carried into effect as the work progresses; and it is to be distinctly understood that all such additional details, working plans, and diagrams are, and shall be regarded by the contractor as of equal force and effect as governing the work to be done under this contract, and are to be considered as virtually embraced and included as a part thereof, and as forming a part of these specifications; and any work which may be required by the specifications, but not shown by any drawings, or which may be required by drawings, but not specially called for in writing in the specifications, is to be executed exactly the same as if shown and described by both of these methods; and, if any workmanship, or materials, be required which is obviously necessary in order to carry out the full intent and meaning of the said plans, details, diagrams, and specifications, although the same may not be either directly or indirectly so specifically noted by drawings or specifications, the contractor is hereby bound to consider and provide for the same in his estimate for the work as fully as if they were so specifically denoted.

Alterations and Deviations.—The engineer may increase, diminish, or alter the work without vitiating the contract. The value of such increases or diminutions or alterations being ascertained from the rates and prices stated in the schedule

annexed to the contract, and being added to or deducted from the contract sum as the case may be.

Extra Work.—No extra work of any kind or description whatever will be paid for by Frederick W. Vanderbilt, Esq., unless it has been executed under a written order signed by the engineer; and a weekly bill of all such work, or such parts thereof as may be executed, must be delivered by the contractor to the engineer during the following week, and the non-delivery of such bill at the proper and stated time will be considered as an abandonment on the part of the contractor of any claim for the amount of such work, and as exonerating Frederick W. Vanderbilt, Esq., from all liability relating thereto. The value of such extra work will be paid for according to the rates and prices stated in the schedule annexed to the contract.

Measurements.—All measurements must be the net dimensions of the work when finished, notwithstanding any custom that may prevail to the contrary.

Materials and Workmanship.—The whole of the works, both as regards quality of materials and mode of execution, must be performed and completed in the most approved, workmanlike, and substantial manner, under the direction, and to the entire satisfaction, of the engineer.

Rejected Materials.—All materials that may be rejected by the engineer must be removed immediately from the vicinity of the work by the contractor.

Use of Land.—The contractor shall not use the land forming the site of or connected with the works for any other purpose whatever than the proper carrying on of the works.

Temporary Huts.—Should the contractor require to erect a temporary hut for his workmen, or other temporary buildings, the sites must be approved by the proprietors of the land.

Trespassing.—The workmen are to be prohibited from trespassing on the neighboring lands, from disturbing the sheep or cattle, and from killing, disturbing, or otherwise injuring the fish or game.

Accidents.—The contractor must use all reasonable precautions to prevent accidents in the carrying out of the works; he will be required, and hereby agrees, to undertake liability for all accidents or damage that may occur in connection with

the carrying out of the works, whether to his own workpeople, to the general public, or to property of any kind, until the works are completed and accepted, and the contractor duly discharged of this obligation. The contractor must also use every precaution to guard against accidents or injury to the works by reason of floods, or by the action or pressure of water, or by frosts, slips, or leakage; and should any such damage take place from such or other causes, he shall forthwith repair and make good the same at his own expense.

Removal of Rubbish.—The contractor shall from time to time remove all surplus and objectionable materials, waste, or rubbish that may accumulate about the works during the term of this contract, and from any land or premises where any portion of the work may be carried on; and on completion of the work the whole of same must be thoroughly removed and cleaned up to the satisfaction of the engineer.

Skilled Workmen.—The contractor will be required to give his personal attention to the faithful prosecution of the work, and always to keep employed upon it a sufficient number of competent and skilled workmen as may be deemed necessary; and the engineer shall have it in his power to dismiss any workman who may be unskilled or inefficient, or who may refuse to obey the instructions given by the engineer.

Must not Assign Contract.—The contractor is specially prohibited from assigning any interest in any part of this contract, excepting only for the furnishing of materials and supplies, without the written consent of Frederick W. Vanderbilt, Esq.

Work Must Proceed.—Should the contractor become bankrupt, or insolvent, or not proceed with the works with all due diligence and expedition within forty-eight hours after a written notice requiring the same has been delivered to him or his representative, the engineer may use, free of cost and charge for wear and tear, all or any of the contractor's men, tools, implements, and materials which may be on the work or in use at the time, and also employ other men, tools, implements, and materials to perform such works as he may require and direct, agreeably with the specification; and all the costs, charges, and expenses of the same shall be deducted from any amount that may be due to the contractor, and retained by Frederick W.

Vanderbilt, Esq., in reimbursement of all such costs, charges, and expenses.

Notice to the Contractor.—All notices to the contractor shall be given in writing, and the delivery of them by mail, at any of the contractor's usual places of business or residence shall be sufficient service.

Watchman.—A watchman is to be kept from sunset to sunrise, on Sundays, and all other times when the works are not in progress until they are completely finished.

Office.—The contractor shall provide an office for the engineer, the same to be provided with desk with drawer, lock, and key, and the window and door provided with necessary fastenings.

Maintenance of Works.—The contractor shall be responsible for, and shall maintain and uphold in a sound and perfect condition, every part of the works for a period of six months from the date of the engineer's certificate of completion.

Period of Completion.—The entire work shall be completed within sixteen weeks from the date of the written order to proceed with the work, under a forfeiture of fifty dollars per week to be paid to and retained by Frederick W. Vanderbilt, Esq., by way of liquidated and ascertained damages, and not by way of penalty, for each week and every week the work shall remain unfinished after the expiration of the period above mentioned.

Completion of Works.—The works shall not be deemed finished or complete until they have been certified to be so in writing by the engineer.

Disputes.—If at any time during the progress or after the completion of the works any disputes or differences shall arise as to the manner of executing the works, or as to the quality of the materials employed, or as to any other matter of charge or account between the engineer and the contractor, or as to any other matter or thing connected with the contract, they shall be referred to and finally settled by Thomas H. Howard, Esq., as sole arbiter, whose decision shall be final and binding on both parties.

Payments shall be made upon the recommendation of the engineer at the rate of eighty per cent. on the value of

work executed under the contract, and in sums of not less than two thousand dollars. Fifteen per cent. will be paid on the completion of the works, and the remaining five per cent at the expiration of six calendar months after their completion, under deduction of all claims against the contractor.

Contract.—Before commencing the works the contractor shall enter into a formal contract with Frederick W. Vanderbilt, Esq., for the execution of the work, providing such security as may be satisfactory to him, which contract shall contain all the usual provisions and stipulations, and he pay one half of the cost of preparing the same.

Tenders.—Tenders on the printed form with bill of quantities fully priced out and addressed to Frederick W. Vanderbilt, Esq., and indorsed "Tender for Highway Bridge," are to be delivered at Hyde Park on or before nine o'clock in the morning of the 16th of May. The right is reserved to decline acceptance of any or all estimates made in response to this invitation.

(Signed)

Date.....

Contractor.

BILL OF QUANTITIES.

The following statement, based upon approximate estimates made by the engineer of the nature and quantities of the work and materials embraced in and required to fill the specifications, and which is stated with as much accuracy as possible in advance, must be understood as being approximate only; and the contractor must satisfy himself and verify its accuracy by personal examination of the specifications, the working plans, the site of the work, and its surrounding conditions, and will not be allowed at any time after the execution of the contract to dispute the accuracy of this estimate, or set up any claims whatever based on its alleged inaccuracy, or to claim any misunderstanding in regard to the nature of said plans and conditions, or amount of the work to be done or quantities of materials to be furnished under such contract.

YARDS.	FEET.	DESCRIPTION.		RATE.	AMOUNT.
74		Cube	Excavation for foundations of retaining walls, abutments of bridge and including every expense.....@	\$ 40	\$ 29 60
38		"	Rock excavation for do. do. do...@	2 50	95 00
169		"	Uncoursed rubble stone masonry in retaining walls, abutments, spandrels, and parapet walls of new bridge set in Portland Cement Mortar.....@	6 25	1,056 25
833		"	Uncoursed rubble stone masonry in road retaining walls set in natural rock cement mortar.....@	3 90	3,248 70
5		"	Uncoursed rubble stone masonry in retaining walls, parapet walls, etc., laid dry.....@	2 00	10 00
	608	Super	Random, level, and broken, stone masonry in face of parapet walls next roadway set in Portland Cement mortar.....@	30	182 40
	120	"	Do. do. do. do. do. laid dry.....@	20	24 00
	196	Linear	Coping stone av. 5 feet long, 25" wide, 4" thick.....@	75	147 00
	96	"	6" dia. drain pipe for road surface drains.....@	25	24 00
			Provide No. 4 iron grids and catch-pits for surface drain.....@	10 00	40 00
800		Super	New road over bridge including all filling material, gravel, and macadam required as set forth in specification.....@	35	280 00
			Take down the present wood bridge, stone piers, abutments, retaining walls, etc., and remove from site..@		
			Provide and fix temporary bridge for highway traffic and remove after completion of new bridge.....@	800 00	800 00
		No. 68	Extrados ring stones of arch each stone av. 2' 6" x 1' 0" x 1' 0".....@	4 00	272 00
			Carried forward.....		\$6,208.95

YARDS.	FEET.	DESCRIPTION.		RATE.	AMOUNT.
			Brought forward.....	\$...	\$6,208.95
	No. 68		Extrados ring stones of arch, each stone av. 2' 6" x 1' 0" x 1' 6".....@	5 00	340 00
	" 2		Extrados keystone of arch, each stone av. 3' 0" x 1' 6" x 1' 0".....@	6 50	13 00
	" 4		Skewback stones.....@	35 00	140 00
	" 18		Keystones of arch, each stone av. 3' 0" x 1' 0" x 1' 6".....@	6 50	117 00
	1976	Super	Voussoir sheeting each stone av. 2' 0" x 1' 0" x 1' 0".....@	75	1,482 00
21		Cube	Cement mortar layer one inch thick on top of arch, spandrels, etc.....@	2 00	42 00
309		Cube	Rubble stone masonry laid in natural rock cement mortar in abutments, foundations, backing on haunches, etc., of new bridge.....@	4 00	1,236 00
	420	Linear	6" x 10" hemlock timber....@	15	63 00
	390	"	6" x 8" " "@	12	46 80
	920	"	6" x 6" " "@	09	82 80
	308	"	10" x 10" " "@	25	77 00
	1180	"	12" x 1" $\frac{1}{2}$ pine ribs.....@	06	70 80
	720	"	6" x 1" $\frac{1}{2}$ pine.....@	03	21 60
	342	"	2" x 8" " "@	05 $\frac{1}{2}$	18 24
		No. 98	12" x 10" " wedges..@	38	37 24
	2212	Super	4" x 2" hemlock lagging.....@	02	44 24
			Provide office for use of engineer...@		
			Provide stakes and pegs, etc., and set out works.....@		
			Provide for preparing plans, surveying, quantities, and specification..... the sum of.....@		226 00
			Carried forward.....		\$10,266.67

YARDS.	FEET.	DESCRIPTION.	RATE.	AMOUNT.
		Brought forward.....	\$....	\$10,266.67
		Provide for engineering supervision, do.....		340 00
		Provide for printing copies of plans, specifications, etc., do.....		58 00
		Provide for preparing contract, bond, etc., do.....		35 00
		Provide for all contingencies, works, and expenses of every description which may not have been included in the foregoing, as set forth in the specifications, and shown on the drawings.....		
		Provide in estimate a sum for sundry small matters not now contem- plated, and not particularized in specification. This sum will be deducted if not expended.....		100 00
		Allow for present wood bridge, tim- ber, and stone on site.....		
		Total.....	\$	\$10,799.67

Note.—The total amount of this estimate must correspond with the amount stated in the Form of Tender.

FORM OF TENDER.

Proposal of.....for building stone Masonry Highway Bridge and other works in connection therewith, situate in Hyde Park, Duchess Co., New York.

Frederick W. Vanderbilt, Esq.

DEAR SIR: I offer to execute the whole of the works, to furnish all the materials, labor, plant, complete, and maintain the works in accordance with the plans, sections, and specification, and with such direction as may from time to time be received from the engineer, for the sum of thousand hundred dollars (\$).

The above amount includes all materials, workmanship, labor, scaffolding, tools, and machinery, and every expense necessary for the completion of the whole work.

In the Bill of Quantities I have given the prices for the various classes of work upon which all extra work will be calculated, and I undertake to complete the whole contract within weeks from the date of receiving order to proceed.

I am, dear sir,

Your obedient servant,

Amount of tender \$..... (Signed)

References..... (Address).....

Address

In Witness Whereof, the parties hereto have signed this instrument, the day and date first above written.

Frederick W. Vanderbilt, Esq., }
by his superintendent of the }
Hyde Park Estate. }

Contractor.....

.....

.....

.....

Signed in the presence of —

.....

.....

Know all men by these presents,

That

.....

.....

.....

.....

are held and firmly bound unto Frederick W. Vanderbilt, Esq., in the sum of (\$.....) dollars, lawful money of the United States of America, to be paid to the said Frederick W. Vanderbilt, Esq., or his certain attorney, his successors and assigns; for which payment well and truly to be made, we bind ourselves, our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Whereas, ... have entered into a contract with Frederick W. Vanderbilt, Esq. through his superintendent of the Hyde Park Estate, for taking down and removing the present bridge over the Crum Elbow Creek on the Albany Post Road in the town of Hyde Park, retaining and parapet walls, piers, etc., and constructing a one-arch stone bridge, retaining walls, parapet walls, and other work as described in the specifications and shown on the drawings, bearing date the day of in the year one thousand eight hundred and ninety-eight.

Now the condition of this obligation is such that if the above-bounden shall, excepting defects due to unpreventable causes, well and truly keep in repair and in good order, for six months from the date of completion and acceptance, all the said stone bridge (over the Crum Elbow Creek in the town of Hyde Park) with parapet and retaining walls and all other works connected therewith to be constructed by the said under the before-mentioned contract, and from time to time shall make all repairs ordered

by the engineer complete within six days of the date of notification to said.....
or his agents that repairs are needed during the aforesaid six months, then this obligation shall be of no effect; otherwise it shall remain in full force and virtue.

In Witness Whereof, we hereto set our hands and seals on this.....day of.....
 in the year eighteen hundred and ninety-eight.

.....(Seal.)
(Seal.)
(Seal.)
(Seal.)
(Seal.)

SIGNED AND SEALED in the presence of

.....

RECENT LEGAL DECISIONS

From the law reporters of the West Publishing Co., St. Paul, Minn.

BOUNDARIES.

1. The corner of a government subdivision of land is where the United States surveyors established it, whether the location is right or wrong.—*Beltz v. Mathiowitz* (Minn. 1898), 75 N. W. 699.

2. If the government quarter section or section post has disappeared, the site of its location, if established by clear and satisfactory evidence, will control and govern as fully as if the original post remained.—*Beltz v. Mathiowitz* (Minn. 1898), 75 N. W. 699.

3. In cases of disputed boundaries, the points marked by the original stakes and monuments placed by the government surveyors, if they can be found, or the place where they were identified, govern.—*Radford v. Johnson* (N. D. 1898), 77 N. W. 601.

4. A warrant for land was issued by the commonwealth in 1794, and a survey was made thereunder in the same year by a deputy surveyor, who died without having made his return. In 1808 his successor in office made return of the survey made by his predecessor as authorized by law, and a patent was issued thereon, under which the land has been held since that time. *Held*, that after such lapse of time the return was not open to question, and the marks of the survey of 1794, if they could be identified on the ground, controlled as to the location of the tract, and could not be displaced by marks of a survey made in 1808, on the theory, unsupported by other evidence, that the surveyor making the return based it upon a new survey made by himself.—*Martin v. Hughes* (U. S. C. C. A. 1898), 90 F. 632.

5. Where the evidence shows a location of a boundary line by adjoining owners, with the obvious intention of making it the true line, acquiescence therein by the parties and their privies for over forty years raises a presumption that it is the true line, which is not overcome by the mere fact that a survey,

made long after government monuments have been obliterated, reveals another line.—*Wollmann v. Ruehle* (Wis. 1898), 75 N. W. 425.

6. Where an irregular tract of land abuts upon a stream, and a meander line is run ostensibly along this shore line for the purpose of fixing the area of such tract, the real boundary of the tract is the shore line, and not the meander line.—*Heald v. Yumisko* (N. D. 1898), 75 N. W. 806.

7. The judgment should be for the defendant, where the plaintiff fails to prove the line he claims correct, even though the line located by defendant could not be satisfactorily established.—*Greif v. Norfolk & W. R. Co.* (Va. 1898), 30 S. E. 438.

8. The burden is on the plaintiff to prove the line he claims correct.—*Greif v. Norfolk & W. R. Co.* (Va. 1898), 30 S. E. 438.

9. Evidence of marks on trees claimed to be line trees was admissible.—*Greif v. Norfolk & W. R. Co.* (Va. 1898), 30 S. E. 438.

10. Where a government survey omits to include large tracts of land lying between a meander line and the stream, the patents for lots along such lines, though referring for identification to the official plat of such survey, which represents the meander line as the border of the water, are grants only to the meander line actually run.—*Barnhart v. Ehrhart* (Or. 1898), 54 P. 195.

11. Courses and distances in a plat referred to in a deed must be made to conform to the established boundaries of adjacent landowners.—*Conner v. Johnson* (S. C. 1898), 30 S. E. 833.

12. An instruction which treats as a non-navigable river a boundary indicated in a survey as "the bed of a dry creek," is not materially defective.—*Barnhart v. Ehrhart* (Or. 1898), 54 P. 195.

13. Where a deputy surveyor general omits to include a large tract of land lying between a meander line as run and a stream to the south, and an action for trespass on the intervening lands is brought by a patentee of lots on the north of such line against one who claims the intervening lands by virtue of a homestead entry thereon, defendant is entitled to an instruction as to the effect of such omission.—*Barnhart v. Ehrhart* (Or. 1898), 54 P. 195.

14. The line upon which a division fence has been maintained for forty or fifty years by the owners of adjoining tracts of land must be regarded as the division line, though the calls of the respective deeds of the owners locate the line at a different place.—*Robards v. Rogers* (Ky. 1898), 48 S. W. 154.

15. Bounds and starting-points are questions of fact to be determined by evidence as in other cases.—*Radford v. Johnson* (N. D. 1898), 77 N. W. 601.

16. The presumption of accuracy given to the surveys of a county surveyor by Rev. Codes, § 2028, refers to surveys made in conformity to that and succeeding sections, and to his measurements and computations, and such other acts as are done pursuant to an exact science, or as are expressly provided for by statute, including field notes and plats, but does not extend to a determination of disputed starting-points or boundaries.—*Radford v. Johnson* (N. D. 1898), 77 N. W. 601.

17. In an action involving boundary lines, a map of a survey referred to in the testimony and field notes of a witness who had made a survey of the premises, is admissible.—*Taylor v. Mc Conigle* (Cal. 1898), 52 P. 159.

18. In an action involving boundary lines, a map of a survey to which reference is made for description in title deeds introduced by defendant, is admissible.—*Taylor v. Mc Conigle* (Cal. 1898), 52 P. 159.

19. An old map, generally well known, and accepted as such, is admissible in evidence in an action involving boundary lines.—*Taylor v. Mc Conigle* (Cal. 1898), 52 P. 159.

20. When a deed gives courses and distances, they govern, disregarding the quantity of acres.—*Quillen v. Betts* (Del. Super. 1897), 39 A. 595.

21. When a deed calls for natural and known boundaries, they govern, to the exclusion of courses and distances.—*Quillen v. Betts* (Del. Super. 1897), 39 A. 595.

22. In ascertaining boundaries from title papers, he who has the oldest title is entitled to take his courses and distances, go where they may.—*Quillen v. Betts* (Del. Super. 1897), 39 A. 595.

23. A survey once placed upon the face of the earth must control a plan that is made from it, although the plan, when

placed upon the earth, would locate the line elsewhere.—*Stetson v. Adams* (Me. 1898), 39 A. 575.

24. Where field notes called for unmarked lines of surrounding older surveys, the position of which could be actually ascertained, and there was no evidence as to how the survey was actually made, it was presumed that the surveyor actually made the survey on the ground, and such unmarked lines prevailed over calls for courses and distances, in case of conflict.—*Waggoner v. Daniels* (Tex. Civ. App. 1898), 44 S. W. 946.

25. A grantee of a lot in a recorded plat, unless the terms of his deed or the plat exclude that construction, takes to the center of adjoining public ways, subject to the public easement; and the fact that the description in his deed, after stating the number of his lot, gives its dimensions, exclusive of the highways, does not effect such construction.—*Brown v. City of Baraboo* (Wis. 1898), 74 N. W. 223.

26. In an action involving boundary lines, where it is necessary to locate the thread of a changeable stream at the time of a particular survey, if the calls for courses and distances in the field notes of the survey lead to where the stream might naturally have been at the time, then such calls tend to show that the thread was where they indicate, and that the surveyor intended to, and did, locate it there, rather than at a point determined, not only by varying the calls for courses and distances, but by disregarding fixed points.—*Taylor v. Mc Conigle* (Cal. 1898), 52 P. 159.

27. Under a deed bounding the land therein conveyed by an artificial pond, which had been in existence for more than forty years, and which had thus become a permanent body of water, and was still being kept up and maintained as such, its waters, however, ebbing and flowing, from time to time, so as to leave a margin of land between its high and low water-marks, the line of the land so conveyed did not extend to the thread of the stream from whose waters the pond was formed, but only to the low water-mark of the pond at the date of the execution of the deed.—*Boardman v. Scott* (Ga. 1897), 30 S. E. 982.

28. An agreement between landowners that a survey shall be made does not justify a surveyor in changing a corner or

line lawfully established by a previous survey.— *Williams v. Atkinson* (Ind. 1899), 52 N. E. 603.

29. The owner of land who causes or consents to a statutory survey loses none of his rights, and is not estopped from claiming title to his land, though such survey remains unappealed from, since it is only prima facie evidence in favor of the lines and corners so run and established, and nothing more.— *Spacy v. Evans* (Ind. 1899), 52 N. E. 605.

30. Where a deed describes the land conveyed by metes and bounds and by the meander line of a river, such line is the actual water-line, unless the contrary clearly appears from the deed itself.— *Sizor v. City of Logansport* (Ind. 1898), 50 N. E. 377.

31. Where a grantor describes a boundary line of premises conveyed as “commencing twelve and one-half feet east of [the grantee’s] house,” the distance must be measured from the foundation of the house.— *Kendall v. Green* (N. H. 1894), 42 A. 178.

32. A boundary line fixed in 1857 by the court, and accepted by the adjoining owners for twenty years, will not be changed to conform with a survey made in 1877 by one of the owners, who thereafter claimed to the new line, and built a fence along that line the following year, and occupied the strip between the old line and the new fifteen years.— *Stark v. Homuth* (Tex. Civ. App. 1898), 45 S. W. 761.

33. Under the law of processioning in Georgia, the location of established lines, not as they ought to be, but as they actually exist, is to be sought; and, where one has been in actual possession of land for more than seven years, under a claim of rights, such claim must be respected by the processioners, even though the land so possessed should be found to be within the original line of the opposing party.— *Bowen v. Jackson* (Ga. 1897), 29 S. E. 40.

34. Where parties acquiesce for fifteen years in a line between two quarter sections owned by them respectively, though the line may vary from the government survey, it becomes the boundary line between the quarters.— *Husted v. Willoughby* (Mich. 1898), 75 N. W. 279.

35. Where the true line between two adjoining owners is

uncertain or unascertained, they may mutually adjust it by parol; and a fence erected on such line, and acquiesced in for thirty years, becomes the legal division.—*Tritt v. Hoover* (Mich. 1898), 74 N. W. 177.

36. A map to which a reference is made in a deed is admissible on a question of boundaries.—*Olsen v. Rogers* (Cal. 1898), 52 P. 486.

DEDICATION.

1. The streets on a defective plat may be dedicated to the public by conveyances made of lots according to the plat.—*Smith v. City of St. Paul* (Minn. 1898), 75 N. W. 708.

2. Where the streets indicated on a defective plat are traveled, and known by the names given them on the plat at the time the deeds conveying the lots therein are executed, the plat can not be said to be so defective in description that it can not, with competent extrinsic evidence, be located on the ground.—*Smith v. City of St. Paul* (Minn. 1898), 75 N. W. 708.

3. A dedication of land for use as a public street does not result from the mere filing of a plat in the office of the county clerk or register of deeds by one who is not the owner of the fee.—*Lewis v. City of Lincoln* (Neb. 1898), 75 N. W. 154.

4. Recognition of a plan of an addition to a town (dedicated thereto by the owners of the land) by the authorities of such town, by an ordinance adopted and published, naming the streets and alleys, and opening and using a part of such streets and alleys, is an acceptance thereof.—*Jarvis v. Town of Grafton* (W. Va. 1898), 30 S. E. 178.

5. Under 1 How. Ann. St. § 1478, providing that, when a street or alley is vacated, the same shall be attached to the lots bordering thereon, and the title thereto shall vest in the person owning the property on each side to the center of such street or alley, the fee of an alley dedicated to the public by a plat reserving to the plattees, their heirs or assigns, the reversion, whenever discontinued by law, belongs to the abutting owners.—*Scudder v. City of Detroit* (Mich. 1898), 75 N. W. 286.

6. Under a common-law dedication of streets, the legal title thereto rests in the abutting lot holders, not absolutely, but subject to the public's easement, and can pass only with a con-

veyance of the abutting land.—Clark v. Mc Cormick (Ill. 1898) 51 N. E. 215, 174 Ill. 164.

7. The side of a street next to the bank of a river, running through a village was not designated in the plat thereof, but other streets opened into it from both sides, and the plat stated that all streets were 66 feet wide. *Held*, that the making and recording of such plat, followed by public travel on such street for more than forty years, constituted dedication of it to the public as such, though St. 1839, p. 160, § 5, requires the plat particularly to describe and set forth all the streets, giving the names, widths, corners, boundaries, and extent of all such streets.—Brown v. City of Baraboo (Wis. 1898), 74 N. W. 223.

8. Non-user for forty years of a portion of a street dedicated as such by the owners, and accepted by the municipal authorities, the other portion having been used during all that time, does not divest the public of the right to open and use the non-used portion whenever the exigencies of travel require it. Judgment (C. C. 1898) 86 F. 30, affirmed.—London & San Francisco Bank v. City of Oakland (U. S. C. C. A. 1898), 90 F. 691.

9. Where any condition is attached to the dedication of the streets in a platted addition to a town, the condition fails, but the grant stands.—State v. Spokane St. Ry. Co. (Wash. 1898), 53 P. 719.

10. When a street is designated on a city plat as of a certain width, and parties buy abutting property with knowledge of, and in reliance upon, such plat, they have a right to have the street maintained at such width, whether there has been an acceptance by the city or not.—Mc Donald v. Stark (Ill. 1898), 52 N. E. 37.

11. Where a street is dedicated as 4 rods wide, and the city accepts the street and works it, the acceptance is for the full width, although it is worked and improved for only a portion thereof.—Mc Donald v. Stark (Ill. 1898), 52 N. E. 37.

12. An addition can not be replatted so as to vacate certain streets therein, where lots though not abutting on the streets attempted to be vacated, have been sold under the original plat, unless all the owners of lots in the plat join in vacating

the street, as required by Code 1873, § 563.—Uptagrafft v. Smith (Iowa 1898), 76 N. W. 733.

DEEDS.

1. Where land is described by courses and distances and also by calls for adjoiners, if there be a discrepancy, the latter governs.—Airey v. Kunkle (Pa. Super. Ct. 1897), 7 Pa. Super. Ct. 112.

2. Part of a quarter section of land conveyed was covered by a lake. The deed described the part conveyed as 140 acres in the east part of said quarter section. *Held*, that the deed was not void for uncertainty, since the land could be laid off in a strip of equal width off the east side of the quarter section, though such strip included part of the lake.—Mendota club v. Anderson (Wis. 1899), 78 N. W. 185.

3. When, by omitting one part of a false or impossible description in a deed, a perfect description remains, the false part should be rejected, and the instrument upheld.—Hayden v. Brown (Ore. 1898), 53 P. 490.

4. Where two parcels of land were of the same description, a deed using the common description, by one having an interest in one parcel only, conveyed the parcel to which grantor had title.—Huffman v. Eastham (Tex. Civ. App. 1898), 47 S. W. 35.

5. A deed excepted from the premises conveyed a portion which had prior thereto been conveyed to a railroad for a right of way. The conveyance to the railroad was an easement in a right of way across the premises, terminating on its ceasing to be occupied for railroad purposes. *Held*, that the exception in the deed was an exception of the fee to the right of way, and not merely an exception of the railroad company's easement.—Reynolds v. Gaertner (Mich. 1898), 76 N. W. 3.

6. D owned a northeast quarter section of land. He deeded a part of it to a son, describing it as the "east half," "the west line being a creek." Part of the land west of this creek was in the "east half" of the quarter section, according to the government survey. In a partition suit between his heirs, his land, described and sold as the "west half" of this

quarter section according to the government survey, came into the hands of a purchaser, whose heirs brought ejectment against a party in possession of the portion of the "east half" west of the creek referred to in D's deed to his son. *Held*, that as only the "west half" of the quarter section was sold at the partition sale, the land west of the creek in the "east half" of the quarter section did not pass by such sale.—*Burnham's Heirs v. Hitt* (Mo. 1898), 45 S. W. 368.

7. A deed conveying real estate to a man and his wife, and their heirs and assigns, forever, creates either a tenancy by the entirety or a joint tenancy; and on the death of one grantee the survivor will take the whole estate by right of survivorship. *Carroll v. Reidy* (1894), 5 App. D. C. 59, distinguished.—*Alsop v. Fedarwisch* (D. C. 1896), 9 App. D. C. 408.

8. The subject of a deed was described as six lots on the northeast corner of H. and B. streets, where the grantor had no land. On the southwest corner of the same streets grantor did own lots similar to those called for in the deed. The deed further described the lots as designated by certain numbers in a plan which was annexed to the deed, and as a portion of real estate conveyed to grantor by a prior recorded deed described. This deed to grantor and plan accurately conveyed and described lots on the southwest corner of H. and B. streets. Grantee took possession of the lots on the southwest corner, and he and his successors subsequently conveyed the lots by a reference to this description. *Held*, that the descriptions were sufficiently clear to pass title to the lots on the southwest corner of H. and B. streets.—*Clark v. Hutzler* (Va. 1898), 30 S. E. 469.

9. When, from the description of a deed, the extent of the property conveyed is uncertain, the acts of the grantee in holding under such deed will be considered in construing the extent of the estate conveyed.—*Jacob Tome, Inst. of Port Deposit v. Crothers* (Md. 1898), 40 A. 261.

10. A deed described land conveyed as "fractional N. W. corner of S. W. $\frac{1}{4}$ of section 6, T. 13, R. 6, containing thirty-three acres." *Held*, that this description operated to convey such a part of the S. W. $\frac{1}{4}$ section 6 as was included between lines drawn an equal distance from the point of intersection of the lines bounding the quarter section at its N. W. corner, and

extended a sufficient distance to include thirty-three acres between parallel lines, and that the word "fractional" should either be treated as surplusage or as modifying "section," as a fractional corner is a contradiction in terms.—*Swan v. New England Mortg. Sec. Co.* (Miss. 1898), 23 So. 627.

11. The term "appurtenances" means only incorporeal easements which are necessary to the proper enjoyment of the estate granted.—*Whyte v. Builders' League of New York* (N. Y. Sup. 1898), 52 N. Y. S. 65, 23 Misc. Rep. 385.

MINES AND MINERALS.

1. Where the foundation of a contract between mining companies for the drainage of a lake, so as to enable them to conduct mining operations under its bed, was the settlement of boundary lines, a division of the territory, and an apportionment of the expenses accordingly, the court must either affirm it in toto or set it aside.—*Pittsburg & L. A. Iron Co. v. Lake Superior Iron Co.* (Mich. 1898), 76 N. W. 395.

2. Where disputed boundary lines have been established by express agreement, and the parties have recognized them, and expended large sums under the agreement, they will be upheld, although title by adverse possession has not been acquired.—*Pittsburg & L. A. Iron Co. v. Lake Superior Iron Co.* (Mich. 1898), 76 N. W. 395.

3. Where mining corporations owning the fractional subdivisions of sections of land meandering along the margin of an inland lake with irregular shores, for the purpose of draining the lake so as to conduct mining operations under its bed, enter into an agreement under seal whereby the boundaries of their respective lands are established, and the terms of the agreement are determined on that basis, and the parties expend large sums under the contract, they are estopped inter se from denying the boundary lines therein set forth.—*Pittsburg & L. A. Iron Co. v. Lake Superior Iron Co.* (Mich. 1898), 76 N. W. 395.

4. The land of a riparian owner extends to the middle thread of the stream, even on meandered streams.—*Goff v. Cougle* (Mich. 1898), 76 N. W. 489.

5. Where the description in a conveyance is faulty, in that

by following the calls and courses, the last point does not coincide with the point of beginning, and by changing the length of one line, the description as to courses, calls, and quantity of land becomes correct, while any other change would vary the quantity of land as well as other calls and courses, the description will be read with said line changed as to length.— *Deppen v. Bogar* (Pa. Super. Ct. 1898), 7 Pa. Super. Ct. 434.

6. One owning a coal mine, adjoining plaintiff's mine, employed a son as bookkeeper and office man, and another son to look after the surface work in the field and around the shaft. The underground work was wholly in charge of a pit boss. *Held*, insufficient to show the sons' liability for coal taken from plaintiff's mine beyond the line of their father's mine, it not being shown that they were bound to know at their peril that plaintiff's coal was being taken.— *Sholl v. Staesser* (Ill. App. 1898), 78 Ill. App. 101.

7. Under How. Ann St. § 8,408, providing that laborers in mines shall have liens for wages due, which shall take precedence of all other debts, liens, or mortgages, and that such liens may be enforced in the same manner, and under the same limitations and regulations, as are provided for the enforcement of other liens, a labor lien is superior to a mortgage lien although the latter is prior in time.— *Atlantic Dynamite Co. v. Ropes Gold & Silver Co.* (Mich. 1899), 77 N. W. 938; *Ishpeming Nat. Bank v. Johnson*, Id.

8. A mining lease for a term of ten years provided that the lessee was to pay a certain royalty per ton on all ore mined, to remove not less than an average of 12,000 tons of ore per year, and to pay a certain amount on royalties in advance, which was to be reimbursed him from the first 12,000 tons taken out. *Held*, that the lease did not require the lessee to remove 12,000 tons each year, but contemplated an average of that amount each year.— *Oglesby's Ex'r v. Hughes* (Va. 1898), 30 S. E. 439.

9. Non-compliance with the miner's rules, or with the State or Federal laws, regarding locations, works a forfeiture of the claim, whether such rules or laws so provide or not.— *Sissons v. Sommers* (Nev. 1899), 55 P. 829.

10 Pending the determination of the title to certain oil

lands, the court appointed a receiver to take charge of and develop the property, the necessary funds to be furnished by the title claimants, with the understanding between them that they were to be refunded to them from the sales of oil, should the same be sufficient. *Held*, that the title to the land having been found to be in one claimant, the other was entitled to such reimbursement.—*Elk Fork Oil & Gas Co. v. Jennings* (U. S. C. C. 1898,) 90 F. 767; *Foster v. Elk Fork Oil & Gas Co., Id.*

11. One complies with a contract to mine ores and to load them on cars free from foreign substance “in a manner satisfactory to” another by loading them on the cars free from foreign substance, irrespective of the manner in which they are taken from the ground and loaded on the cars.—*Worthington v. Given* (Ala. 1898), 24 So. 739.

12. In an action for a breach of contract to permit plaintiff to mine ore in a specified territory, and to pay for it when delivered free from foreign substances in a manner satisfactory to a furnace company, evidence of the quality of the ore is immaterial.—*Worthington v. Given* (Ala. 1898), 24 So. 739.

13. One agreeing to permit another to mine ore in a specified territory, and to pay a certain sum per ton therefor, must permit the mining of ores remaining in the territory after deliveries of large quantities, which included ores taken outside the territory, amounting to more than the ores remaining in the territory.—*Worthington v. Given* (Ala. 1898), 24 So. 739.

14. Prospective purchasers of mining property have a right to rely on statements made to them by the owners as to the presence of extensive beds of ore at the bottom of certain pits and trenches, and are not called upon to go into them and determine the truth by dipping out the water or digging out the earth with which they are partially filled. 80 Fed. 41, affirmed.—*Green v. Turner* (U. S. C. C. A. 1898), 86 F. 837.

15. A lease of the privilege of withdrawing natural gas from the soil, reserving annual rentals during its continuance, is a leasehold interest, and unaccrued rents pass by a conveyance of the land.—*Chandler v. Pittsburg Plate-Glass Co.* (Ind. App. 1898), 50 N. E. 400.

16. In an action to recover the sum agreed to be paid for

the right to enter upon plaintiff's land to explore for coal, and to mine and remove the same, money paid by defendant as annual rent for coal prior to the commencement of mining operations, and intended by the parties as compensation for the postponement of such operations, will not be credited upon the agreed price of the coal, when removed, though the language of the agreement is appropriate to pass a present title to the coal.—*Wonsetler v. Andrews* (Ohio 1898), 51 N. E. 168, 58 Ohio St. 551.

17. The statutes regulating mining do not supersede the common law except where they are at variance, and a compliance with all the statutory requirements by a mine owner does not relieve him from liability for acts or omissions which give a right of action against him for negligence under the common law.—*Consolidated Coal Co. v. Bokamp* (Ill. App. 1898), 75 Ill. App. 605.

18. Where the lessees of a mine which the lease provided should be worked continually, or the lease be forfeited, assigned an undivided interest in the lease to O, on condition that he comply with the terms of the lease, and afterward assigned their remaining undivided interest to B, O, doing all the work on the premises, is entitled to a lien on the interest of B for his share of the work and expenditures necessary to preserve the lease.—*Beck v. O'Connor* (Mont. 1898), 53 P. 94.

19. Under a coal lease, the lessee was to mine and ship from the premises certain coal annually, and to pay for that quantity whether mined and shipped or not. The lease also provided that, should the seam of coal "prove faulty in the strata or unmerchantable in its quality, the said lessee shall have the right to abandon the same, with the right to remove all the improvements by said lessee erected on or under said premises." *Held*, in an action for the rent, the burden of proof being on the lessee to show that the coal was unmerchantable or not to be found upon the premises, that the question was properly one of fact for the jury.—*Wilson v. Beech Creek Cannel Coal Co.* (Pa. Super. Ct. 1898), 7 Pa. Super. Ct. 241.

20. A lease of all the merchantable coal under the land covers all the veins, even those which at the time it is unprofit-

able to work.—In re Maffet's Estate (Pa. Orph. Ct. 1897), 9 Kulp, 136.

21. A lease for the purpose of operating for oil and gas for the period of five years, and so much longer as oil or gas is found in paying quantities, on no other consideration than prospective oil royalty and gas rental, vests no present title in the lessee except the mere right of exploration; but the title thereto, both as to the period of five years and the time thereafter, remains inchoate and contingent on the finding, under the explorations provided for in such lease, of oil and gas in paying quantities.—*Steelsmith v. Gartlan* (W. Va. 1898), 29 S. E. 978.

22. The completion of a non-productive well, though at great expense, vests no title in the lessee.—*Steelsmith v. Gartlan* (W. Va. 1898), 29 S. E. 978.

23. Such lease must be construed as a whole, and, if there is no provision therein contained requiring the boring of another well after the first unsuccessful attempt is completed and abandoned, the lease becomes invalid, and of no binding force as to any of its provisions.—*Steelsmith v. Gartlan* (W. Va. 1898), 29 S. E. 978.

24. When one holding a lease for all the coal underlying the land of another, so long as coal is found in paying quantities, fails for eleven years to work the mine, and the openings to said mine cave in, the lessor, and those claiming under him, have a right to consider said lease abandoned.—*Welty v. Wise* (Ohio Com. Pl. 1897), 5 Ohio N. P. 50.

25. The lessees of a partially worked-out coal mine are not liable for damages by subsidence caused by excavations made by their predecessors prior to the date of their lease, though they took no measures to arrest the subsidence.—*Greenwell v. Low Beechburn Coal Co.* [1897] (Eng. 1897), 2 Q. B. 165.

26. A purchaser of the title to coal underlying land, with a right of way into, upon, and under the land for the purpose of mining the coal, has the right, as against the owner of the land, to haul through the gangways of the mine coal mined under adjoining land, so long as the mine is necessarily kept open to mine coal still remaining under the former land.—*Webber v. Vogel* (Pa. 1899), 42 A. 4.

DRAINS.

1. 3 How. Ann. St. § 1740g3, provides that the drain commissioner shall relay any drain that has been located and constructed or partially constructed when the proceedings have been declared void for any cause other than that the drain is unnecessary and not conducive to public welfare, and reassess on the land benefited the original cost, together with the expenses of relaying and completing. *Held*, that the commissioner can relay a drain where his prior attempt was void for want of jurisdiction.—Hauser v. Burbank (Mich. 1898), 76 N. W. 109.

2. Under How. Ann. St. § 1740h4, as amended by Laws 1893, pp. 336, 337 (providing that where a natural water course needs cleaning out, deepening, or widening, and there have been no proceedings to establish such water course, it is immaterial whether the first proceedings shall be to clean out, deepen, or widen, “but the commissioner shall take such steps as may be necessary to obtain a right of way as heretofore provided, and go on with his proceedings in the manner provided by law”), the commissioners, under a petition to lay out a drain along the general course of the creek, may include portions of the creek, and deepen, widen, or straighten the same.—Hauser v. Burbank (Mich. 1898), 76 N. W. 109.

3. The names of certain owners of land traversed by a proposed drain were omitted from the application to the probate court. The parties omitted did not complain. A release was given the drain commissioner, by an adjoining owner, of a sufficient quantity of land to accommodate the entire ditch at that point. *Held*, other owners could not complain.—Hauser v. Burbank (Mich. 1898), 76 N. W. 111.

4. Under Laws 1885, c. 5, § 3, providing that proceedings establishing a drain shall be subject to review only on certiorari, and section 5, providing that the township board may review assessments for error or inequality, resort must be had to the courts, and not to the township board, in order to contest the validity of drainage proceedings; and therefore on appeal to the township board from assessments of the drain commissioner of one county, the drain commissioner of another county, who

acted in conjunction with the former in laying out the drain, is not a necessary party.—*Thomas v. Board of Walker Tp.* (Mich. 1898), 74 N. W. 1048.

5. Laws 1885, c. 5, § 1, provides that the drain commissioner shall assess the costs of the drain, and fix the per cent. of assessment to the township and to lands benefited. Section 2 provides that owners of lands assessed may appeal to the township board. Section 5 provides that the board shall hear the allegations and proofs of the parties on appeal, and if, in their judgment, there be manifest error or inequality in the assessments, they may order such changes to be made as they deem just. *Held*, that the board has no power to change the boundaries of the drainage district, and to exclude lands which the drain commissioner has determined were benefited.—*Thomas v. Board of Walker Tp.* (Mich. 1898), 74 N. W. 1048.

6. Where the lower end of a drain overflows, adjacent lands with water collected by it from the upper lands, which it sufficiently drains, the cost of enlarging the lower end, or of constructing a new drain, to carry off the waters collected by the old, may be assessed against the upper lands, since their owners had no right to flood the lower lands by artificial drainage.—*Culbertson v. Knight* (Ind. 1899), 52 N. E. 700.

7. Under Burns' Rev. St. 1894, §§ 5655–5658 (Rev. St. 1881, §§ 4285–4288), authorizing the construction of drains whenever conducive to public health or of public benefit, and requiring lands benefited thereby to be assessed for their construction, whether passing through the same or not, lands already sufficiently drained, whose value, for tillage, or for residence purposes, or for the market, is enhanced by a drain which does not reach them, are subject to assessment for the cost of its construction.—*Culbertson v. Knight* (Ind. 1899), 52 N. E. 700.

8. Where the lower end of a drain overflows the adjacent lands with water collected by it from the upper lands, the viewers, in assessing the cost of a new drain to carry off the waters so collected by the old drain, can consider that the upper landowners are liable to be enjoined from discharging on the lower lands the waters collected by them by artificial drainage.—*Culbertson v. Knight* (Ind. 1899), 52 N. E. 700.

9. Under Pub. Acts 1885, No. 227, as amended by Pub. Acts 1893, No. 203, c. 8, § 1, requiring the same proceedings for widening or extending drains as for locating them, and providing for cleaning established drains on application of a majority of the property owners assessed for their original construction, and making it discretionary with the drain commissioner to fix the assessment for cleaning on the same basis as for the original construction, notice of the letting of a contract for cleaning the drain need not be served personally on every person whose land is affected by such assessment.—*Lanning v. Palmer* (Mich. 1898), 76 N. W. 2.

10. Where a drain was cleaned pursuant to a petition therefor, petitioners were estopped from questioning the validity of the proceedings taken to clean it because of mere irregularities.—*Lanning v. Palmer* (Mich. 1898), 76 N. W. 2.

11. The owner of a higher tract of land has the right to have the water falling or naturally coming on his premises pass off through the natural drains upon or over the lower or servient lands adjoining, and to construct ditches or drains on his own land to conduct such water into the channel provided by nature, and this right is not restricted or abridged by the drainage act of 1889.—*Helm v. Richmond* (Ill. App. 1897), 72 Ill. App. 516.

WATER-SUPPLY.

1. The city of Detroit owns its water plant, which is in charge of a board of water commissioners first created by Acts 1853, p. 182, § 9, which authorized them to borrow moneys for construction purposes on the credit of the city, and gave them power to fix the water rates "on such basis as they shall deem equitable." Section 13 provided for a sinking fund from the surplus water rates or other sources to pay the interest and principal of the bonds issued for the money borrowed. Section 24 provided for a water tax on taxable property of the city to meet deficiencies in the revenue. Acts 1873, No. 302, § 2, requires a levy of \$75,000 annually to be paid to said board to be first applied on the interest of the bonds, the surplus to go into the sinking fund. Water was furnished practically free to the city for public uses, to the board of education for the schools, and to charitable institutions. The amount borrowed

since 1853 from time to time, as authorized by the legislature, amounted to two million dollars, on which only about half a million has been paid. *Held*, that an assessment of water rates by the board on the basis of the expenses of extension and construction and the payment of the bonded debt, as well as the actual operating expenses, was equitable; and that the acts did not contemplate a payment of the bonded debt and the interest entirely by the city, but by the private consumer, especially where no direct tax other than the \$75,000 had ever been assessed.—*Preston v. Board of Water Com'rs of City of Detroit* (Mich. 1898), 76 N. W. 92.

2. A water company, which had the right to lay its pipes and water gates in the streets of defendant city, can not recover of the city the expense incurred in changing the water gates, caused by the city making changes in the surface of the street and the line of the sidewalk, necessary to render the street safe and convenient for travel.—*Belfast Water Co. v. City of Belfast* (Me. 1898), 42 A. 235.

3. An agreement to place hydrants on not less than six-inch pipes is not "substantially complied" with by putting them on four-inch pipes.—*Belfast Water Co. v. City of Belfast* (Me. 1898), 42 A. 235.

4. A water company agreed with defendant city to furnish it forty-five hydrants at such points as the city should designate, and if the city desired additional hydrants, the company would furnish the same at a specified annual rental for each hydrant, and if the city should desire five hydrants additional to the forty-five located, so as to require no more pipe than should be necessary to connect up the forty-five hydrants, the company should place the five hydrants without additional charge. The company further agreed to connect the forty-five hydrants, located as aforesaid, and all "such additional hydrants," in such a manner that none of them shall come on pipe smaller than six inches in diameter. *Held*, that the "additional hydrants" mentioned in the last clause are not limited to the five additional hydrants to be furnished free of charge.—*Belfast Water Co. v. City of Belfast* (Me. 1898), 42 A. 235.

5. There is evidence of negligence to carry the case to the

jury in an action against a city for the bursting of a water main belonging to it, causing plaintiff's property to be flooded, by a showing that it had burst before under ordinary pressure; that at the time of the accident there was no unusual pressure, or reason why it should have then burst; and the testimony that water pipe of its size and dimensions, when properly constructed and laid, will not ordinarily burst under such a pressure.—*Esberg-Gunst Cigar Co. v. City of Portland (Ore. 1899)*, 55 P. 961.

6. The people of the city, by accepting a charter creating and naming a water committee, and vesting in it a commission subsequently to be appointed, first by such committee and thereafter by the governor, power to construct, manage, and control the water system belonging to the city, accept such committee and commission as their agents to carry on the work.—*Esberg-Gunst Cigar Co. v. City of Portland (Ore. 1899)*, 55 P. 961.

U. S. INSPECTION OF LAND SURVEYS.

GEO. E. STEELE.

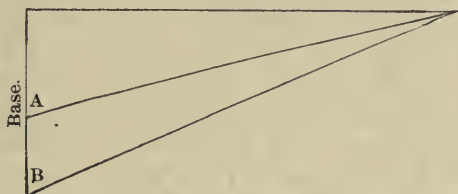
THE United States Land Office Department of Interior has found by many and varied experiences and trials that when a surveyor takes a contract for the survey of the public lands, he is just honest enough to bear watching. Don't let me forget to say, though, that as a class they are as honest as any. But while all men are liable to error, and especially those who go forth to mark the bounds of the public lands, over mountain and stream, through dense and thorny jungles, and across precipitous cañons, when the error increases so you may call it a mistake, and the mistakes get to be so frequent and glaring that the surveyor knows of them, and finally swears they are correctness itself, then is a good time to call a halt, for fear you might call some one a liar. These being the primary conditions, it is found best, before paying for surveying contracts, to have enough of each job inspected to determine whether it has been done as the Manual of Instructions points out that it must be ; whether, for instance, the courses are correct as to true meridian, and agree with the notes ; how are the measures ? what monuments or witness trees ? are the trees marked correctly, monuments notched, and on the right side ? if any pits are dug, are they at good depth, length, and width, and properly placed ? if a mound of stone is called for, does it turn out to be a few spades of earth ? if a resurvey, were the old corners measured in and then destroyed ? if the deputy reports mountains, timber, or heavy brush on line, which will give him more per mile, do you find it so, or did he make one of his little "mistakes" when the mountains and brush failed to "sprout," in closing on reservations or grants, are the corners properly set and marked ? These and many other conditions must be ascertained. The one to report them is the duly appointed inspector, supposedly a man of integrity and qualification. Some of his ability may be further stated as backbone, both to stand the strain of mountain travel and the pull between the deputy and the department, if all is not right ; accurate and quick in handling and adjust-

ing an instrument ; expertness to see where he can get a base for a triangulation, or whether he had better rely on two good chainmen ; two eyes to close on small errors and open wide at frauds ; two good hands to save his transit on that ledge of rock, and to write fully and exactly every item of work he goes over, without giving the department any advice ; two ears to take in all evidence of the deputy's doings, including the items in cash he took from the settlers for officially setting their corners (the ones the United States contracted with him to set) ; and a tongue that never says "damn." He might need to be good in figures, though it is not necessary to be a profound mathematician. Inspectors have been sent out seemingly as political favorites, who wore patent-leather shoes, and took more meals at high-priced hotels than in the field. Their work had more mistakes than that of the deputy. An error of one inspector in one mile we found of over six chains. A line of a deputy in crossing a high ledge was bent sixty-seven links out of a right line. A triangulation of a deputy was in error *on his note-book* of 8.06 ch. ; another of the same kind, 4.56 ch., taking his triangles as he recorded them. Some courses were way off.

One of the most important qualifications for this work is that seeming gift to find an obscure corner, the patience to pursue it, and take evidence. Would that all our young men taking an engineer course could see the value of this trait, no matter whether they have much to do with lines and corners or not. *Persistent* is about the word. Wherever this inspection work is done, the settlers have come in advance, some of them many years, and still have no title ; nor can they have till the Plats are approved and filed. So the inspector must have them in mind also, and be fair to their interests. It is a delicate position. In taking observation on Polaris, which came not too late at Western elongation, after getting the star and watching it a short time till it seemed to be stationary, we removed all light and *changed the object glass enough to blur the focus*. The star will give light and both cross hairs can then be seen and centered precisely. Try it. Also set fire to a small dry stick,—perhaps of pine,—and with the glowing coal (not the flame) throw the light on the cross hairs, and see the

star at same time. No troublesome lantern need apply ! Perhaps some do not realize in observing how important it is to level the instrument *precisely*, so that the telescope will follow a vertical line. It is also very well to set a hub both north and south of the instrument, and leave the tripod till the next morning, without disturbing.

A good check on a triangulation is to take two readings on the base. It will take little more time provided the way is clear, or you can select such a site ; thus at A B,—



In fact, so work as to check every operation, or come as near as possible to this rule.

MICHIGAN ENGINEERING SOCIETY.

BUSINESS TRANSACTIONS OF TWENTIETH ANNUAL CONVENTION.

THE Twentieth Annual Convention of the Michigan Engineering Society was held in Lansing, Jan. 24 and 25, 1899, and was largely an anniversary meeting. The society was heartily welcomed to the city by the mayor, whose address was suitably responded to by President Greene. The leading professional paper by Mr. Riggs, on "Paving Streets in Small Towns," was a very valuable paper, and more thoroughly discussed than any other paper presented, and it is much regretted that untoward circumstances have prevented its publication in this ANNUAL. We hope to get it for a future number.

The business meeting was held Wednesday afternoon. Before proceeding to business, Mr. E. W. Muenschler presented resolutions which were unanimously adopted, relative to the death of Mrs. E. F. Hodgman, who had been a regular attendant, with her husband, at the meetings of the society for a number of years. Overpowering feelings prevented the secretary from making any response or acknowledging how fully he appreciated the kindly, generous sympathy of the society.

The secretary read the report of the annual meeting of the board of directors held in Lansing, Sept. 21, 1898, which report was approved by the society. It is as follows:—

ANNUAL MEETING OF THE BOARD OF DIRECTORS.

The annual meeting of the board of directors of the Michigan Engineering Society was held at Hotel Downey in Lansing on Wednesday, Sept. 21, 1898. There were present President Rogers, Secretary Hodgman, Director Skeels, and members Appleton and Vedder. Ballots for officers were canvassed, and the following declared elected:—

President, Chas. E. Greene; Vice-President, J. J. Hubbell; Secretary-Treasurer, F. Hodgman; Directors, J. B. Davis, Wm. B. Sears, and Dorr Skeels.

The reports of the secretary and treasurer were read and approved. The memberships of Thos. Campau, Clark Corn-

well, Albert Eaton, J. F. Meighan, C. G. Taylor, and H. L. Thayer were annulled for non-payment of dues.

The applications of F. L. Church and E. O. Sellers for withdrawal were granted, and Mr. Church's dues remitted. The names of Wm. Appleton and John J. Watkins were presented and approved for honorary membership. It was voted to hold the next Annual Convention at Lansing, Jan. 24-26, 1899, and Messrs. Appleton and Vedder were appointed local committee. The application of P. E. Harroun was approved for senior membership. Action in W. G. Clark's case was deferred until Mr. Riggs could be consulted. The case of Geo. E. Steele was considered, and after the close of the meeting a letter was received by the secretary explaining that the cause of non-payment of dues was severe financial reverses, and by the unanimous action of the board he was endorsed as a candidate for honorary membership.

F. HODGMAN, *Secretary*.

The following reports made to the board of directors, and approved by them, were read for the information of the society :—

MICHIGAN ENGINEERING SOCIETY, SECRETARY'S REPORT.

I would respectfully report the following business transacted by me for the society since my last report. Immediately after the Annual Convention, I let the job of printing the annuals to the Review and Herald Publishing Company, of Battle Creek, and proceeded, in connection with the committee, to secure such advertising as I could. I also had a quantity of the amended constitution and by-laws printed, copies of which have been furnished every member of the society. The ANNUALS were out in May, and sent immediately to our advertising patrons and societies and others with whom we exchanged reports. 2,000 copies were published, of which about 1,875 copies were sent out as before stated, and to our members. Arrangements for exchange of reports were made with sixteen societies, from less than half of which reports have been received up to the present time. Ballots for members were sent out the first Monday in March, and canvassed as required by the by-law, and the several candidates elected as announced in the ANNUAL.

One of the candidates, Mr. W. G. Clark, of Toledo, although twice notified, has failed to pay his senior membership fee, and his membership should be declared forfeited unless the board of directors see fit to extend the time of payment. Since the ballots were sent out I have received the application for membership of Mr. P. E. Harroun, of Albuquerque, N. M., which is hereby submitted for your approval.

The following members are more than two years in arrears for dues, and their memberships should be annulled. They have all been notified as required by By-law No. 7, and no response received: Thos. Campau, Clark Cornwall, Albert Eaton, J. F. Meighan, C. G. Taylor, H. L. Thayer.

Mr. F. L. Church, of Mitchell, Mich., has applied for withdrawal. His application came immediately after 1898 dues became payable, and he asks that they be remitted as he finds himself unable to meet them. Ballots for officers were sent out August 15, and so many as have been returned are hereby submitted for canvassing.

One of the hardest trials the secretary has to meet is the refusal of a large majority of the members to answer the letters he sends them. So far as he can judge, his letters are simply fired into the waste-basket without reading.

The secretary wishes to acknowledge the effectual work done by Messrs. Riggs, Wells, and Rogers of the committee on advertising, which enables the secretary to report the society free from debt, and he hopes that their work for the next ANNUAL may begin before our Annual Convention, so that firms who place their advertising orders the first of the year may be reached in time, and that we may not be forestalled by other societies in securing their patronage.

F. HODGMAN, *Secretary.*

TREASURER'S REPORT.

SEPT. 21, 1898.

To the Board of Directors of the Michigan Engineering Society.

I would respectfully report the following sums received and disbursed by me for the society during the past fiscal year:—

RECEIPTS.

Amount on hand at last report.....	\$ 48.28
Received from advertisers	399.00
“ from membership fees.....	46.00
“ from members for dues less collection fees.....	343.80
“ from sales of reports.....	38.25
	<u>\$875.33</u>

DISBURSEMENTS.

For expenses of board of directors including secretary's expenses on ANNUAL.....	\$ 37.19
Paid Smith & Co. balance on 1897 ANNUAL and exchange.....	119.85
“ Review and Herald Pub. Co., for 1898 ANNUAL and reprint of papers.....	317.84
“ secretary as voted by the society.....	175.00
“ stenographer.....	47.60
“ for miscellaneous printing.....	29.05
“ stamps and envelopes	29.47
“ freight and express.....	20.48
“ miscellaneous expenses, copyright, etc.....	8.85
	<u>\$785.33</u>
Leaving a cash balance on hand of	90.00
	<u>\$875.33</u>

There are no outstanding accounts against the society.

There is due from advertisers.....	\$39.00
“ “ members 1 year's dues.....	69.00
“ “ “ 2 “ “.....	60.00
“ “ W. G. Clark mem. fee.....	2.00
	<u>\$170.00</u>
“ “ members 3 years dues N. G.....	63.00

F. HODGMAN, *Treasurer*.

Subscribed and sworn to before me a Notary Public in and for Kalamazoo County, Mich., this 20th day of September, A. D. 1898.

WILBUR C. POND, *Notary Public*.

The following persons were then nominated for officers of the society for the ensuing year:—

For President, J. J. Hubbell, of Manistee.

For Vice-President, H. E. Riggs, of Toledo.

For Secretary-Treasurer, F. Hodgman, of Climax.

For Directors: Dorr Skeels, of Grand Rapids; A. J. Teed, of Cadillac; H. K. Vedder, of Agricultural College; C. E. Bement, of Lansing, and M. Walker, of Port Huron.

It was voted that the secretary be paid \$175 for his services during the past year.

The society then proceeded to revise its committees. The committee to prepare model ordinance for regulating the franchises of electric street railways, was discontinued as a standing committee, and made a special committee of three to report at next convention. H. E. Riggs, E. W. Muenscher, and John J. Granville were elected such committee.

The committee on forestry was revised by relieving J. J. Hubbell and John Randall from service, and adding Mr. A. J. Teed, of Cadillac, to the committee.

The committee on the relation of sewerage and water-supply to the public health was revised by relieving G. S. Williams and H. E. Riggs from service on that committee, and making Frank F. Rogers chairman of the committee, the remaining members to be appointed by the president.

The committee on materials for street paving was revised by substituting Mr. Dorr Skeels in place of E. W. Muenscher.

The committee on twentieth anniversary was excused from further service after the close of the convention, and the thanks of the society extended them for the work done.

The committee on advertising was made a standing committee, and revised to stand as follows: Geo. L. Wells, chairman, and Messrs. Walker, Parks, A. L. Holmes, and C. Holmes.

A special committee, consisting of J. J. Granville and Geo. M. Ames, was elected to investigate fillers for brick pavements and report at next convention.

The committee on Clark monument made the following report, which was approved, the expenses of the committee as shown by bills presented ordered paid, and the committee continued to complete some unfinished work.

MR. PRESIDENT: Your committee on the Clark monument makes the following report:—

About the first of May Mr. Rumsey and myself went on the ground, and, from the field notes, located the position of the white oak as shown on the annexed sketch. About the tenth of June we wrote the State Land Office asking for what there was in the records of the office in regard to R. Clark, Jr., and in particular all about his death. On June 15 we received the following reply:—

From State Land Office, Lansing, Mich.

Township 8 North Range 11 West, Michigan.

West on south side Sec. 31. Begin at old meander post on left Bank Grand River.

9.75 over river and set meander post.

{ St oak 16 S 35 W 2.8
 { W ash 6 N 62 $\frac{1}{4}$ W



25.55 W oak 40

28.00 Brook 10 course south

35.00 Leave bottom and raise bluff

42.43 Intersect west boundary 6.00 north of post. Set post cor. of T.
 7 and 8 N. Ranges 11 and 12 W.

{ W oak 20 N 75 E 17
 { do. 20 S 4 E 66.

Bottom land, low and rich. Maple, ash, elm, etc.

Upland G and W oak.

NOTE.—The foregoing line was run by R. Clark, Jr., up to W oak station, where he *died*.

To die thus is going on some other shore —
 Ere well we feel the friendly stroke, 't is o'er.

This is all that is said about the death of R. Clark, Jr., in the field notes of U. S. Survey of lands in that section of country.

BOWEN, *Clerk*.

On the same date, June 15, we sent a letter to Mr. John M. Clark, of Chicago, Ill., of which the following is a copy:—

We understand you are a son of R. Clark, Jr., Deputy United States Government Surveyor, who died while at work in this State near this city. The Michigan Engineers' Society proposes setting a monument, a field boulder, at the place where United States' field notes say he died. Will you kindly send us a short biographical sketch of him, as a surveyor, and particularly all you know of his death? Any suggestion or wish of yours in this matter will be kindly received.

Yours truly,

D. SKEELS, }
 JAS. L. RUMSEY, } *Committee.*

On July 10 we set the stone for the monument, which we found some 600 feet away from the spot where he died. The party who moved it estimated its weight at 6,500 pounds. We

made an excavation of one and a half feet, let the stone into it, and filled in around with concrete.

July 22 we received the following letter from Mr. John Clark:—

D. Skeels, Esq., Grand Rapids, Mich.

DEAR SIR: I beg to acknowledge receipt of your letter of June 15 in reference to a monument proposed to be erected by the Michigan Engineers' Society, at the spot where my father, Robert Clark, Jr., died while in the execution of a contract for survey of public lands for the government.

Your letter came during my absence from the city, and was held here awaiting my return, which will explain the delay in its answer.

As I was only six months old at the time of my father's death, and my mother being also now dead, I fear I may not be able to give you of my own knowledge, or from documents now at hand, as full particulars as you would like touching his life and professional work. But rather than longer delay an answer to your kind letter, I will give you such information as I now have, and should further details be desired, will endeavor to procure them.

Robert Clark, Jr., was born in Hartford, Washington Co., N. Y., Aug. 4, 1804. Was educated at an Academy, I think in Delaware County, but its name or exact location I am not able to state. His father, Dr. Robert Clark, represented his district in the United States Congress for two terms, and was appointed by the president as registrar of the land office at Monroe, Mich., and came to the west with his family in 1821. I do not think Robert Clark, Jr., was ever engaged in other business than that of surveying, and was chiefly employed in the survey of government lands. He executed a number of large contracts in Michigan, Illinois, Indiana, and Wisconsin.

He was married in Florence, Mich. (near Three Rivers), on Dec. 24, 1831, to Mary E. Fitch, eldest daughter of Judge Charles B. Fitch, of St. Joseph County. He died while at his work near Grand Rapids, Mich., March 20, 1837. He left two children, an elder brother and myself. My brother was born in White Pigeon, Mich., March 3, 1834, and died in Chicago, Feb. 20, 1864.

I never had the privilege of a personal knowledge of my father, but the esteem in which his memory was ever held by those who knew him best, by his neighbors and many friends, bespeaks a character in which his children and his professional brethren may take a justifiable pride.

I should be glad to be informed further as to action taken by the Engineers' Society.

I do not know that I have any suggestion to make or wish to express further than my cordial approval of the proposed action of the society, and that I would be glad if permitted to co-operate with them in the proposed work.

I am very truly yours,

JOHN M. CLARK

We sent him a reply as follows:—

JULY 22, 1898.

John M. Clark.

DEAR SIR: Your very kind reply of the 14th is hereby acknowledged with thanks for the data furnished.

The stone is set,—a granite boulder about 3 x 4 feet in diameter, and about five feet above the ground.

As you express a wish to co-operate with the society in this if not asking too much, would you like to furnish a tablet of bronze or some other metal to be placed on the stone? All the society cares to have on the tablet would be—

“Erected by The Michigan Engineering Society in memory of Robert Clark, Jr., who died on this spot March 20, 1837, while in the discharge of his duties as Deputy United States Surveyor.”

On July 29 we received the following:—

I beg to acknowledge receipt of your communication of the 22d in regard to bronze tablet to be placed on the boulder which has been placed by the Michigan Engineers' Society to mark the place where my father, Robert Clark, Jr., died while in the discharge of duty. I will at once take the matter up and find if such tablet can be cast here, procure a design for the same, and submit same for your approval.

Thanking you and the Michigan Society of Engineers for your courtesy in this matter, I am,

Very truly yours,

JOHN M. CLARK.

And the next day, we received the following:—

Enclosed herewith please find design for bronze tablet, upon which I would be glad of your opinion.

It is a little larger than I thought it ought to be, and my instructions were to have the third and fifth lines in larger type than the rest of it. The size and shape of the stone will determine the best size and shape of the tablet. This design is, I believe, about 15 x 20 inches. If there is no flat place on the stone large enough to receive it, one would, I suppose, have to be made by the chisel. The enclosed is simply the design prepared by the artist employed by the contractor who is to do the work. Please do not hesitate to criticize it, or to make any suggestion that may occur to you or to members of the society to whom you will show it. We want to have it as nearly right as we can get it. Awaiting your reply, I am,

Very truly yours,

JOHN M. CLARK.

To which we replied on July 30:—

Your favor of the 28th inst. received. We think the tablet should be not larger than 8 or 9 by 12 inches. Also the fifth line *must* be in larger type. Am very much pleased with the design.

On August 4 we received this in reply :—

Enclosed please find new design for tablet, which I think meets the principal objections raised against the other. This is drawn in exact size, and gives a better idea of what the tablet itself will be like. It is to be cast in bronze, the letters raised, with the surface polished, background dark.

If this meets your approval, please advise me, and I will give the order for the work. I will be at the expense of the tablet, and when finished, it will be shipped direct from the factory to you, and I assume that you, as representing the Engineering Society, will see that it is put in position.

When done, I would be very glad to run over to Grand Rapids to look at it. Please return the design. If any suggestion occurs to you that would improve it, please do not hesitate to make it.

Very truly yours,

JOHN M. CLARK.

To which we replied with this:—

AUG. 5, 1898.

Yours of the 4th instant received with tablet design enclosed. We think it much better than the other, and it fully meets our approval. When the tablet is set, we will have some photographs of it, and forward to you.

Advise us when you take your run over here.

Suggestion: I do not know how, but would like to have your name appear on the tablet.

August 8 we received this from Mr. Clark:—

Yours of the 5th enclosing design of tablet received this morning. I have seen the parties, and ordered the tablet cast, and instructed them, when completed, to ship it to your address. It will probably be finished in about two weeks. My contract with the company is that it should be of best material and finish, and to be delivered on board cars properly packed, with necessary bolts for attaching it to the stone, and instructions as to how to set it.

Am much obliged for your suggestion that my name appear on the stone tablet, but it seems best to me that it should not. The work was designed and in the main carried out by the Michigan Engineering Society, and it is proper that their name only should appear. Will advise you when I can come over to look at it.

Allow me to express my sincere thanks to you and to your society for the action taken, and believe me,

Very truly yours,

JOHN M. CLARK.

On September 1 we received this letter:—

The bronze tablet is completed, and so far as I am able to judge, is entirely satisfactory. It will be shipped to you to-day from the founders. I am going east to-night to be gone about a month. Some time after my

return, will be very glad to run over to Grand Rapids to see the monument, and will advise you before coming. Will you kindly write me at Marion, Mass., and let me know if the tablet reaches you in safety, and how you are pleased with it.

JOHN M. CLARK.

On September 5 we acknowledged receipt of the tablet with the following letter:—

Yours of the 1st just received. The bronze tablet came as you anticipated; is satisfactory in every respect, and will be set to-morrow. We can not express our thanks for the part you have taken in this enterprise, and will only say we hope the monument will please and suit you.

About the first of October we had a telephone from Mr. Clark from some place in Indiana, saying he would be here the coming Sunday. We met him at the Morton House, and drove out to where the monument is. He was much pleased, and expressed entire satisfaction with everything that had been done.

Your committee feels very grateful toward Mr. Clark for the prompt and active part taken by him in this matter.

Respectfully submitted,

D. SKEELS, } Committee.
JAS. L. RUMSEY, }

At the close of the business meeting the board of directors held a meeting to consider applications for membership. The following persons were approved for membership, and have been elected by letter ballot:—

W. W. Brigden, Battle Creek, Mich.; P. E. Harroun, Albuquerque, N. M.; R. J. Hill, Detroit, Mich.; C. W. Hubbell, Detroit, Mich.; E. F. Moore, Lansing, Mich.; H. E. Moore, Grand Rapids, Mich.; Charles Palmer, Escanaba, Mich.; James C. Riley, Jackson, Mich.; Wm. R. Ryan, Port Huron, Mich.; Geo. B. Willcox, Bay City, Mich.; A. S. Van de Mark, Detroit, Mich.

FOR HONORARY MEMBERS: Wm. Appleton, Lansing, Mich.; John J. Watkins, Guthrie, O. T.; Geo. E. Steele, Los Angeles, Cal.

The remainder of the Convention was devoted to anniversary exercises and social meeting. Music was furnished by Miss White, of Grand Rapids, Mrs. Parks, Mrs. A. L. Holmes, Miss Lucy Hodgman, F. Hodgman, and Mr. G. Carver, of Climax.

THAT COMPASS: A REMINISCENCE.

DORR SKEELS.

IN the fall of 1883 we went to Mississippi to survey a tract of pine. We took with us an open compass, from Young & Sons, Philadelphia, the best compass we ever used; so good was it that one of the assistants took it, giving us \$50. On our return we sent to the same firm and ordered a new one. The instrument we got, is "That Compass." It is a good instrument, and we are very much attached to it. The first time we used it was in tracing a line out east of our city. We had finished our work, and coming out to the street-car line, we set it down near the track.

In setting it down the leg of the tripod nearest the track, set just on the side of a fence post-hole grassed over. As we turned to take the tape and pins, over it went, one sight-bar striking the end of a tie, and bending the bar about an inch and a half in. That hurt. Taking the bar to the shop, we soon had it straightened, and good as new. All went nicely until the fall of 1884. A party wished to have a section S. and E. of Baldwin subdivided into forties. On the way to the depot, we put that compass on the tripod, the "click" telling us that "all was right." As we lifted the tripod to our shoulder, off went that compass to the stone sidewalk, striking on the end of one of the sight-bars, bending it over and sideways. It looked like anything but a surveyor's instrument. We took it into the shop when we got to camp, and with the use of the vise and hammer straightened it, and did the work.

In the fall of 1886, we went over to Wisconsin, to subdivide some twenty sections into forties. The Wisconsin river runs through the tract, and where the Tomahawk River comes in, the Wisconsin turns from a west course to one southeasterly.

We had a canoe, which we used in going to and from our work, pulled by two stalwart French Canadians, excellent boatmen.

One night coming to camp, which was on the river some two miles below, where the Tomahawk comes in, being cold,

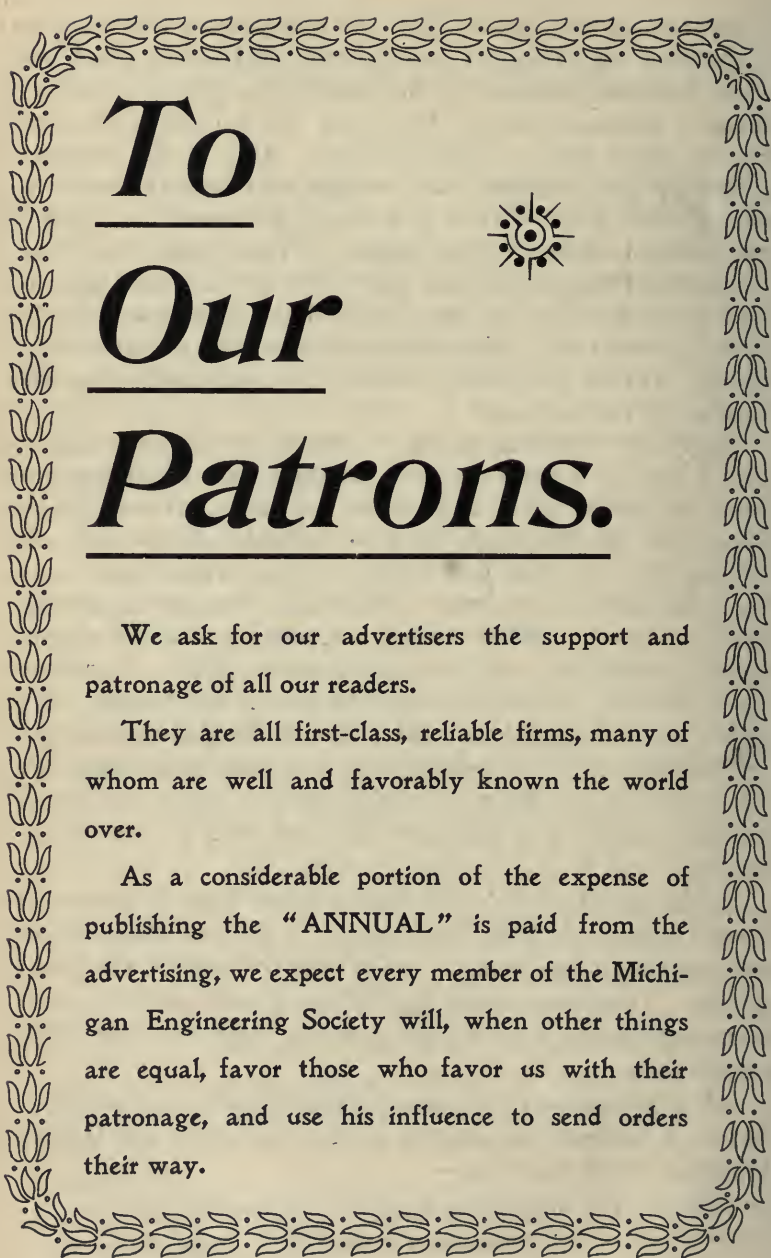
three of us left the canoe, after carefully placing that compass in the stern out of danger, and took the road across, which was about half the distance by the river. We got in some time ahead of the canoe party. When the canoe came to the landing, we went down to get our tools. One of the boatmen picked up that compass, and brought it to us very carefully, saying, "Sir, I don't know just how it got done, but think it was when I traded setting poles." Yes, 't was done: that compass had the glass broken into more pieces than there are days in the month. The rim that held the glass was bent, the center pin was bent. Well, the surveyor is not a profane being; oh, no! It took four days to send it to, and get it from, the shop at the nearest town.

Early the following spring we started out one morning to trace a line for a party that was cutting a tract of timber into wood, he driving us out with horse and cutter. The sleighing being poor, we frequently took to the side of the road. In turning into the road one runner of the cutter caught in a wheel rut, and over we went. I had that compass on my lap, sight-bars down. When we got the horse and cutter righted up and around, we went for that compass. It was there face down, the sight-bars driven into the ground full length. We took it up, both sight-bars bent outward, the glass broken, the rim holding it bent, the needle gone, center pin badly bent. We did not find the needle, and as this was too much of a job for our shop, we sent it to Beckman's hospital for a general repair. In proper time it came out good as new.

In the fall of 1888 we took that compass down to Tennessee in the Cumberland Mountains region. Late one afternoon we were running a line along a steep bank of one of the many ravines. There were some two inches of snow on the ground. Hurrying to make a certain point before dark, we stepped on a small pole.

All practical surveyors are possessed with a something—we call it instinct; our worthy brother, our good, old Deacon Appleton, never thinking,—

"It were better far,
To remain as we are,"

A decorative border of stylized leaves and flowers surrounds the central text.

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at the beginning of the New Year, ever sings : —

“Oh, for the New Year a new heart,
May the old sins be all erased ” —

might characterize it by some other name,— that which causes them to hold to and protect their instruments regardless of injury to self. We slipped, coming to the ground on our back, with that compass clasped tight. Sliding down the steep bank of the ravine head foremost, the head took a notion to go between two trees, there not being sufficient room for our shoulders to follow. There was a sudden stop; but that compass took the notion to go on, and try to go through another tree. When we got down some fifty feet to the bottom of the ravine, there lay that compass. We kindly took it up, only one sight-bar was bent, and the plate sprung some. At camp, with the aid of an ax, a log, and block of wood, we righted it into shape, but the neck and shoulder was a number of days getting into proper adjustment.

In the summer of 1891 we were coming in from tracing a line in the south part of the county, with that compass and tripod on our shoulder. Our office was on the third floor, and we were about half-way up the second flight of stairs, when that compass went off the tripod, and down the stairs to the bottom. As we turned to look at it, we thought to leave it there, but good-fellowship prevailed, and we took it to the office. Both bars and the plate were badly bent, the glass broken in three pieces.

The next morning taking it apart, we took all but the needle to a locksmith. He said it could be hammered into shape, so we left it. But somehow, after that hammering, it seemed to lose its vitality.

The little daughter of a certain M. D., wishing to see a baptism by immersion, was told she might go down to the water one day, and witness the ordinance. When she came home, the doctor asked her what the minister said, and she replied, “He said, I baptize you, your father, your son, and in the hole you go,” so about four years ago, we put that compass in the box.

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LETTER FROM WM. B. SEARS.

SAGINAW, MICH., Jan. 22, 1899.

To the Michigan Engineering Society, Greeting.

GENTLEMEN: A feeling of remorse has taken possession of me since I decided to turn the cold shoulder on the coming anniversary meeting at Lansing, and were it not for pressing engagements and poor health, I should reverse that decision, and be with you, if it were simply to shake hands, say "How d'ye do," and "Good-by."

My dreams have been about you for many days, if we include the night and make "the working day" twenty-four hours. In youth and early manhood we want to sleep the greater portion of the time; at least this was my inclination at fourteen to eighteen years of age, when the corn-rows were long, the field large, weeds high and thick, and the June sun coming down straight, almost as penetrating as the Roentgen ray. How long the days! Oh, how long! That sun seemed to stand still in the heavens, and would never, never set. When at night a thunder-storm arose, and the rain began to patter on the roof overhead, it was sweet music to boyish ears, and we earnestly prayed that it would rain all night and a goodly part of the coming day; for this would stop the plow, and give us a chance to go gunning or fishing.

Many times, however, these prayers were vain, and came to naught, because the prudent father was thinking of other things than hunting and fishing. He had peas to stick, and cabbage, tobacco, and sweet potatoes to plant; and, you all know — particularly those of you who were raised on the farm — with what gusto and pleasure a rustic lad of fourteen to sixteen abandons a hunt, and, barefooted, rolls up sleeves and trousers, takes a pointed stick in hand, bores holes in the ground, and stooping low in the broiling hot sun, plants cabbage and tobacco all day! It makes the back and the heart ache, if he happens to be near the margin of the woods, where the birds are singing their merriest songs, and the squirrels are barking at him from the favorite hickory tree.

H. E. RIGGS,
Mem. Am. Soc. C. E.; Mich. Eng. Soc.

W. J. SHERMAN,
Mem. Mich. Eng. Soc.; Eng. Club of St. Louis.

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After fifty years the scene has changed. That summer sun goes down, burdened with life and light — vanishes like a passing ray — all too soon to meet the wants or pleasure of “the old man.” Days seem but moments passed, weeks turned into fleeting hours, and the passing year condensed into about twelve working days of “the long ago.”

Now, gentlemen, you have my estimate as to the passage of time, and the aspirations or feelings of youth and age, and will readily excuse my absence when you reflect that only twelve working days have passed since I bade you good-by; and no reasonable man would ask me to write a whole history in the brief space of time such as scheduled by my good friend Hodgman. You have asked me for something reminiscent, and I have carried you back to the cabbage patch; but, as cabbages are now planted, and the sweet-smelling kraut, as well as senators and presidents, now made by the aid of machinery, and you happen to be on the ground where this machinery operates smoothly for the good of “the operators,” I will discard the morals of legislators, and speak for the benefit of the younger members present about “the morals” of engineers.

To many of you I have frequently said that the surveyors and engineers are the salt of the earth; and the older I grow, and the more I become acquainted with men, the stronger grows this conviction. There may be a selfish, greedy, black sheep in the flock now and then for sale, but these are rare birds, and soon drift out of the profession and into other callings.

Our good friend Colonel Muenscher showed us last year that municipal work could be done better and cheaper by paying laborers a fair wage, and dispensing with the contractor, under honest supervision, than can be attained through favoritism and boodle. The people may be swindled for a time, but not for all time; and just here is the inviting and profitable field, in my judgment, for the honest, competent, well-trained, and faithful engineer.

A short story, and I ’ll quit : Forty-five years ago, at the age of twenty-two, with limited knowledge and experience on public work, but under the tutelage and supervision of a kind,

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Absolutely Indispensable to the Prospector, Miner, Chemist, Engineer, Metallurgist, Manufacturer, Banker, Investor, and Legislator.

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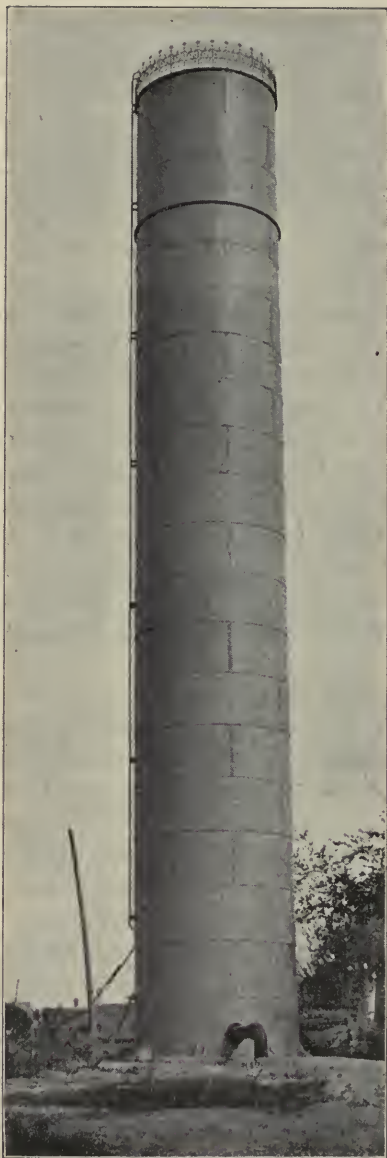
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honest, industrious, and painstaking engineer, I had charge of ten miles of heavy work near Barnesville, O., on what was called the Central Ohio railroad, now part of the B. & O. system. The excavations and embankments were stupendous works compared with anything we have in Michigan, cuts and fills ranging from forty to sixty-five feet in depth, and about one half of the excavations composed of loose and solid rock. I walked through one of these long, dark, deep cuts in the month of June, 1854, on a tour of inspection with Contractor Allen (not a descendant, we hope, of Colonel Ethan Allen, of Revolutionary fame, but made of coarser stuff and unrefined), who carried a magnificent gold watch and chain with seal attached, purchased evidently for this special occasion, judging by the manner in which it was displayed, and the frequency with which he noted the time o' day. My old quartier, with ten-cent ribbon attached, which I had purchased four years before for ten barrels of good, sound winter apples, picked and sorted with care, and hauled four miles to market over hilly roads, was dross,—the poorest kind of dross, in these days of gold standard,—compared to Allen's gem. On reaching the center of the big cut, Mr. Allen called a halt, saying:—

“Sears, you know my prices—earth excavation 16 cents, loose rock 22 cents, solid rock 40 cents per cubic yard. Now, if you will move the line of that loose rock two feet higher, and the line of solid rock six feet higher, it will make a vast difference in my final estimate. Mr. Thompson, the division engineer, has the utmost confidence in you, and your final will pass without inspection or criticism. By making this change, which will never be detected,—never,—you can own this gem of a watch and chain that cost me in Wheeling, Va., last week \$250.” Knowing the man for twelve months previously, who seemed to be fair and honorable in dealing with his men, I was astonished at his duplicity, and the brazen attempt to bribe me. I said, “Mr. Allen, this time you are mistaken in your man. An honorable father taught me that ‘honesty is the best policy,’ and I shall not swerve from the line of duty to fill your purse, or that of any other man. I will watch you in the future, and see to it that the balance of your work is well and



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faithfully executed. I will give you in the end every yard honestly earned, nothing more and nothing less."

Now, gentlemen, it cost no effort and little backbone to do this, for I had been reading for some three or four years formerly the lives of Washington, Franklin, Jefferson, and Lafayette, and had imbibed too many good things from that ever-living poet, who says :—

“ What tho’ on homely fare we dine,
Wear hoddin gray, and a’ that :
Gie fools their silks, and knaves their wine,
A man ’s a man for a’ that !
For a’ that, and a’ that ;
The honest man, though e’er sae poor,
Is king o’ men for a’ that.”

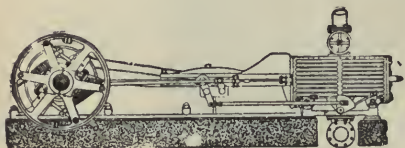
Good-by. yours truly,

WM. B. SEARS

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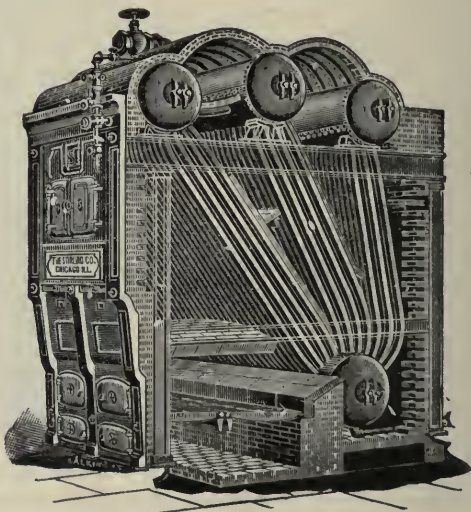
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REMINISCENCES.

WM. APPLETON.

To the Michigan Engineering Society, on the Twentieth Anniversary of its Existence.

MR. PRESIDENT AND GENTLEMEN: It is an honor to be called on to say a few words at a time like this, when we are stopping for a brief space to look back at the last one fifth of a century, to review our actions, call up the past, and view it go before us as a panorama, and see if our conduct during those twenty years, in every particular, as men and members, has been all we could wish, so that we can not see how it could be bettered, if we were to live it over. If we see no mistakes or errors, then are our reminiscences in vain. Others, no doubt, have seen and noted our shortcomings, and it may be well for us to lay by all our conceit, and, as saith Burns, "See ourselves as ithers see us ; it will from mony a blunder free us and foolish notion." This was probably the meaning of the Roman god Janus, from whom the month January is named, having two faces, and stationed at the end of the old, and at the beginning of the new year. He could look back into the past to get knowledge and experience with the one, while with the other he is looking into the future, being guided by the wisdom gained in the past. So be it ours to imitate this emblem of wisdom, to scan our past, and store experience for future use, but forbid, O ye guardian genii, that we be deceitful or two-faced, to betray a friend or debase our manhood.

I feel wholly incapable to call up gone-bys in a humorous manner, to make a laugh. There is but little of the ludicrous has taken place in this society. The first few yearly meetings were characterized by such a gloomy, cloister-like wisdom that melancholy settled about us thick as Sir Walter's Dryasdust. Why, the gravity of countenance and majesty of mien was appalling. So much so that one of our members hailing from Ohio was constrained to say in his paper that an engineer must know everything, or let on that he did. But, my dear Mr. Priest, a change was at hand ; just when the fog of reserve

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was thickest, the sun of geniality was at work thawing the ice of primary selfishness, till at a meeting at Saginaw, Frost, of the *Engineering News*, burst forth: "Is this a Methodist meeting? What ails you fellows?" The effect was as a spark to a mine. The effulgent rays of good-fellowship fired the hearts of those present, smiles replaced forced gravity, and the strait-laced mannerism was relegated to hades, and a hearty good feeling now awaits the men who may walk and talk with the scores of well-read men who have honored this society with their kindly words and friendly teaching. I believe it is just to the society to say that it has bettered even the best of them; but at a time as now, when our memory is so busy, how keenly do we feel our losses by the grim destroyer! Hush, my friends! These are hallowed thoughts, sacred to the memory of our dear departed. Our Pearsons, a two-story man, an intellectual giant,—do we not feel, as saith the prophet, "O that my head were waters, and mine eyes a fountain of tears"? But, brethren, others of our members who have met with us in earlier years, have paid the debt of nature, and will advise us no more, nor relate more of their experience. We may go to them, but they shall not come to us. Talk of reminiscences, who of us does not miss that sweetly sympathetic face, who has gone in and out among us for years, who by her calm devotion has endeared her memory to us in a way our strongest has not? May we cherish their memories, and as far as poor, frail mortals may, imitate their many virtues. With different feelings, though with sorrow, we have had to say good-by to many of our best workers. They were of us, but fortune decreed, and they went out from us; yet it is a pleasure to us they left us their best respects. Carpenter, Sherman, and Steele,—what a trio of members they were! There were many others. Time fails us to note them, but let us ever be grateful it has been our privilege to be associated with such men in a mutual desire to do and get good. It has been a noble work. Let us still do good, and we shall certainly get good. While not forgetting our erstwhile fellow laborers, and heaving a sigh for their lost company, let us take heart, and anew put our shoulder to the wheel, look over our roll of members, and read there the names of men still with us, famous for skill in research, patient in

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investigation of theory, well-balanced in their perceptions, quick to detect the false from the true, and thus while they welcome every genuine advance, have the good sense to prove all things, and hold fast only to the good and valuable.

Friends, look around you. Are you ashamed of your company? Look at them: Greene, Davis, Skeels, Muenschler, Hodgman, Teed, *et al. ad infinitum*. You have never heard of strife among them, which of them should be the greatest. They have all borne the burden and heat of the day, and are still in harness, seemingly at their best. Besides these wheel-horses, see the younger sons of the prophets, only waiting for the mantles of the sages to fall on them, and they, too, will show their mettle, and like those gone on before, they will leave an untarnished record.

In a society like ours, we may have weak men; we could not possibly all excel, but I believe we could furnish men here now present capable of any work in our profession likely to be undertaken by the present generation. I suppose as I have nothing to say, I ought not to say it, but the spirit moveth, and the warning, like Lochiel's, may best be heeded—it costs nothing.

When this craft of ours was first designed, no dimensions were specified. A keel was laid, ribs, knees, etc., were used of such material as came to hand. There was plenty of it, such as it was, and of superior quality, what there was of it, and a tight little bark was launched; a good sailer, well ballasted, manned by a grim, sturdy, and gallant crew, captained by as able a commander as ever trod a quarter-deck. He it was who put the good ship on her course, and made her first voyage successful, and her owners rich. He it is we honor here to-night by an appreciation of his services. After him came our genial friend J. B., persevering in the discreet yet fearless ways of his predecessor. We gained prestige and influence through him and succeeding able leaders. Our ANNUALS grew to be an authority, and our membership was large and respectable. Dropping metaphor, we found when we came to possess a few relics, donated by that estimable old pioneer surveyor, Mr. Coffinberry, of Grand Rapids, that we could not hold them legally, and a meeting was called in the

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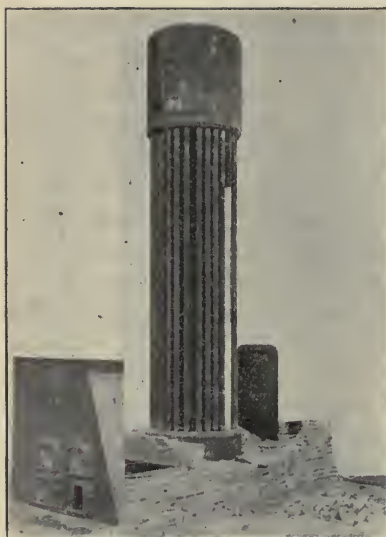
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city surveyor's office in this city, and our present charter, constitution, etc., followed. This was largely the work of Davis and Greene, our first presidents, but participated in by all the signers as they now appear. So far, then, we make a good showing, even our finances being fair; but don't let us forget that, except a short time after Carpenter, we have had an exceptionally efficient secretary. In the interims of meetings the business is attended to, the ANNUAL is brought out in good season, the ads are not forgotten. May this always last, and we always have the right man in his place, but if we should not, then a little misgovernment, a slip of imprudence, a pang of jealousy, many unforeseen things, may occur to cause a declension.

During the first quarter of the eighteenth century, that grand old institution, which has stood the trials of all ages of history, and going back where the prying eyes of the curious can not follow, it had taught the enlightening truths of civilization in all ages. It furnished the only lamp to guide mankind through the darkness and ignorance that enveloped the world. Whether the pegs on which hang their sublimely moral lessons are mystical or literal is of no account. With them only was light in the surrounding gloom. Yet with all this in its favor, how nearly it died we may never know. Phoenix-like it has arisen reconstructed, and though the change was opposed by such mighty men as the architect Wren, we have the revived substance with us. If such could happen to such a wonderful, I had almost said miraculous, institution, what may be the future of this fragile thing of ours? It paid to bring it forth. Let us guard it tenderly, not tire of it, make it a necessity, govern it with wisdom, lead it with prudence, and take care of the bag; so shall this bantling of ours be known and trusted throughout the State. If any one of us should get that dreadful disease known as swell-head, look a long ways back. There were tunnels under tideway rivers hundreds of years before Brumel was born. The Cloaca Maximo was another, the Parthenon flood another, the Via Aqueduct in Provence another, all right in our own dooryard. They are, or were, of so little moment, their designers and builders are alike forgotten. If the poor, vain insect still *thinks* he is quite a



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fellow, let him think of all the works in the arts and professions that have been done by unknown men, that he, poor thing, thinks are beneath him. This is a specific. If self-esteem is still present in undue proportions, bring him to these annual conventions, where there are a lot of stub-and-twist members who would go coolly, calmly to work to bridge the gulf between here and the Philippines, or pale Moses' little job by draining the Indian Archipelago. I know if they undertook it, it would surely be done, and on time.



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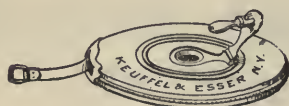
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A TOAST—CURVES AND TANGENTS.

J. J. HUBBELL.

MR. TOASTMASTER, LADIES AND GENTLEMEN: I believe that some members of this society think I am a crank on curves, and I am not sure but that they are right. I do love a nice, well-turned curve. I have no objections to a tangent, provided it starts from the right place, goes where it is wanted, and ends where it ought to; but so few tangents fulfil these three conditions that I am usually obliged to resort to curves.

Nature is said to abhor a vacuum, and it is almost equally certain that she seldom uses a tangent. The Creator, who traced the routes for the rivers and brooks, gave them graceful, serpentine curves, and those who study nature tell us that they would never have been able to perform their allotted tasks had they been laid out as tangents with some one's transit. Had some engineers had their way, they would have become a very common lot of ditches and canals.

Many a beautiful site for a village has been spoiled by the mistaken idea that its streets must all be tangents, its lots squares and parallelograms; and many a public road has been rendered almost useless by being run straight over hills and across valleys, when nature had provided a way upon much easier lines.

The earth labors, and brings forth a mountain. There are no tangent lines about it, yet it stands as a monument to its Creator, grand and beautiful in its proportions.

The human architect erects his building; its lines are straight, its angles square, its wall plumb, yet it will not compare with the handiwork of God. An eminent divine of London directed that his church be constructed on a perfect circle, and when an anxious parishioner inquired why he had it built round, he said, "To keep the devil out of the corners." If he was right, then much of our architecture furnishes ample accommodations for his satanic majesty.

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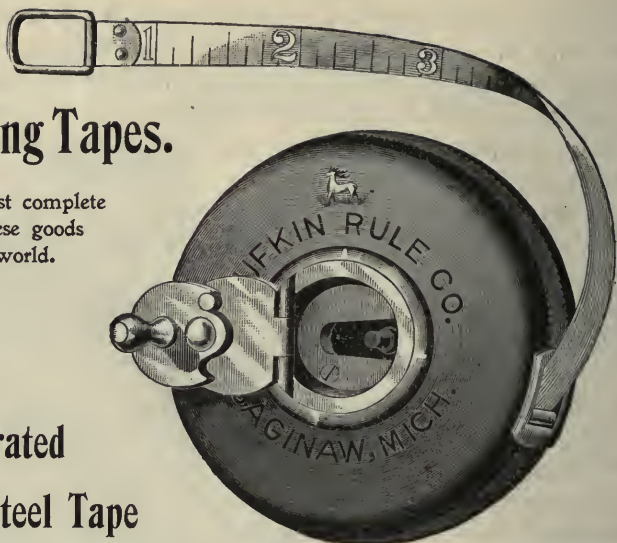
level any distance before you discover that the world itself has a hump on it, and your level line becomes a vertical curve. Your north and south lines and your east and west lines, a compound curve. The world is a globe, and together with the sun, moon, and stars moves and has its being upon curved lines.

There is a moral sentiment abroad ; something about the straight and narrow path which would seem to indicate that all lines that are not tangents are crooked, and if crooked, bad lines, but the truth is, right lines can be drawn with the compasses as well as the straight edge, and a combination of the two are usually the best lines.

There is a proverb of King Solomon's which I think was especially designed for the direction of engineers. He says, "The foolish and the simple man passes on and is punished," he goes straight on to destruction ; "but the wise and the prudent man foreseeth the evil, and hideth himself." This should teach us never to run our tangents straight on to an obstruction, but to look ahead, and when necessary, put in a curve.

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F. HODGMAN.

THE meanest kind of a lie is one which has enough of truth in it to give it a standing and a send-off. One wrinkled, baldheaded old lie of that sort, that has been going up and down the world since the time when the memory of man runneth not to the contrary, is that "two of a trade can never agree." It never was wholly true as to any trade or profession, and I believe is less true of our profession than of most others. Men of similar tastes and likings, who have similar aims in life and similar aspirations, are wont to band themselves together to carry out these aims. If perchance they are thrown together in a common work, they stand shoulder to shoulder in fighting the battles of life; if beaten, they go down together; or if triumphant, they together share the fruition of their hopes and labors, the ties of friendship are likely to be drawn very closely between them, and sometimes these ties become even stronger than those of blood relationship. Men who shared with me the trials and labors of a pioneer railroad survey in the great West became very near and dear to me, and when one of them, a pure, generous, warm-hearted, whole-souled lad, laid down his life in the wilds of Colorado, it struck home to me as few losses have ever done.

Here in our society, some of us have been working hand in hand for a score of years. We have been doing work which has brought together men of like tastes, thoughts, and aspirations; and while its immediate aim has been our own pleasure and improvement, yet at the same time we have been doing vastly more for others, for the public and the world at large, than we have for ourselves. While doing this, ties of good-fellowship have been formed which have brightened many a day, lightened many a load, and aided many a brother craftsman better to solve the problems which meet him in his daily life. The fellowship of the Michigan Engineering Society is some

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thing to be proud of, to be thankful for ; and no one can realize it or be more grateful for it than your secretary, whose life has been uplifted and brightened by it for, lo, these many years. May it never be less. May the good work of the society go on, and its good-fellowship grow warmer, purer, and better when those of us now present shall have joined with Love, and Forster, and Pearsons in the great world beyond the river.

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